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Determining Input Variables for Calculation of Impact of New Source Performance Standards: Worksheets for Mineral Products Industries

Research Corp of New England, Wethersfield, Conn

Prepared for

Environmental Protection Agency, Research Triangle Park, N C Office of Air Quality Planning and Standards

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DETERMINING INPUT VARIABLES FOR CALCULATION OF IMPACT OF NEW SOURCE PERFORMANCE STANDARDS: WORKSHEETS FOR MINERAL PRODUCTS INDUSTRIES

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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16. ABSTRACT

The purpose of this document is to present the results of a study to determine the impact of new source performance standards on nationwide emissions. The work presented covers 14 potential pollutants from approximately 200 source categories for the year 1985. The results are being used by EPA as input to the development of an overall standard setting strategy. The report contains information regarding controlled and uncontrolled emission factors, State emission limitations, industrial capacity, utilization, growth and retirement rates. The results of this study have been published as three volumes which encompass ten separate documents. This document contains Appendix 4D of Volume II - Calculation Sheets for the Mineral Products Industry.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS		c. COSATI Field/Group
Air Pollution Air Pollution Control Industrial Processes Combustion Regulations Economic Factors	Priorities Chemical Industry Paper Industry Petroleum Industry	Metal Industry Agricultural Mineral Flyash Exhaust Gases	

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by

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Contract No. 68-02-1382

EPA Project Officer: Gary D. McCutchen

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
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April 1977

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Publication No. EPA-450/3-76-018-d

FOREWORD

During 1974, two studies were initiated that ultimately resulted in the establishment of priorities for developing and promulgating New Source Performance Standards (NSPS). The procedures used to determine these priorities produced a great deal of information that is believed to be useful in the industries involved and, accordingly, is being published in this series of reports (EPA-450/3-76-017, EPA-450/3-76-018, EPA-450/3-76-019, and EPA-450/3-76-020). This information is organized as follows:

EPA-450/3-76-017 discusses (1) the mathematical model (Model IV) used to determine NSPS impacts over a 10-year period; (2) the methods used to attain input variables; and (3) the summary tables which are the heart of this study. Included in the summary tables are data related to (1) emission, growth, and replacement rates; (2) present and future production and capacity; (3) nationwide emissions; and (4) NSPS impact. These tables include information on 13 pollutants and nearly 200 stationary source categories.

EPA-450/3-3-76-018-a, -b, -c, -d, -e, and -f are the calculation sheets, showing how the input vairables reported in EPA-450/3-76-017 were derived. All information sources, assumptions, and calculations are documented and explained. The appropriate worksheets are arranged alphabetically in the following volumes:

018-a - Stationary Combustion Sources

018-b - Chemical Processing Industries

018-c - Food and Agricultural Industries

018-d - Mineral Products Industries

018-e - Metallurgical Industries

018-f - Miscellaneous Sources (Evaporation Losses, Petroleum Industry, Wood Products Industry, and Assembly Plants

The 018-a -f series is of interest only to those concerned with the detailed calculations used to determine the Model IV input variables.

EPA-450/3-76-019-a provides additional results and information produced during the priority study. Its major purpose is to describe the computer program used to rank all the Model IV input and output variables by pollutant (these rankings are reported in 019-b and -c). In addition, it contains (1) summaries of the control systems considered "best" for each source, (2) equipment retirement ages, and (3) emission trends for each source category.

EPA-450/3-76-019-b and c present the computer-generated ranked data for each pollutant. Ranking is from highest to lowest for each of the 21 variables, e.g., A (nationwide capacity) and E_u (uncontrolled emission rate). Volume 019-b contains ranked data for particulate, nitrogen oxide (NO_x), and sulfur oxide (SO_x) sources. In Volume 019-c, the remaining pollutant sources are ranked: hydrocarbons, carbon monoxide (CO), fluorides, hazardous material, acid mist, lead, ammonia, sulfides, chlorine, and trace metals.

EPA-450/3-76-020, the final document in this series, takes the objective impact values from EPA-450/3-76-017, adds subjective judgements, and uses these combined criteria to produce a priority list for NSPS development. The report then calculates nationwide emission trends over the next 15 years for each criteria pollutant (particulate, SO_x, NO_x, hydrocarbons, and CO) based on a series of scenarios (e.g., no NSPS, 20 NSPS per year, etc.)

In summary, documents EPA-450/3-76-017 and 020 present the results of this study. Each stands alone, but they also complement each other, with 020 building on the results of 017. The remaining documents (018-a -f and 019-a -c) present additional and/or more detailed information derived from the impact and priority studies.

DETERMINATION OF INPUT VARIABLES
FOR
THE MINERAL PRODUCTS INDUSTRY

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

K:

Ref 044 (Technical Report No 6)
p 13

Identifies a typical asphalt batching plant of 150 T/hr capacity with an annual production of 112,500 T/yr. This they explain is based on 50% on-stream time.

an estimate of capacity utilization (K) is made based on an assumed operating schedule which is believed typical.

$$8\frac{hr}{d} \times 5\frac{d}{wk} \times 40\frac{wk}{yr} = 1600\frac{hr}{yr}$$

$$150\frac{T}{hr}\text{ap} \times 1600\frac{hr}{yr} = 240{,}000 \text{ T/yr capacity}$$

$$K = \frac{112{,}500}{240{,}000} = .469 \quad \text{or} \quad K \cong .47$$

This implies that if we consider the 50% on-stream time figure mention above; During an operating [illegible] of 8hr/d, 5d/wk, 40 $\frac{wk}{yr}$ the process is operating at peak capacity (design) however it is only in production ≈ 50% of the time.

$\therefore$ K = .47

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Computation Sheet For Industrial Factors

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Source Asphalt Batching

P_c: Ref 044 p 13

a 10% annual growth in asphalt production has occurred in the past several years and .1 compound is expected to continue through the near future

however, the reference also states that in 1968 there are 4800 plants with 200 new plants expected to be constructed each year.

$$\text{Plants in } 1975 = 4800 + 7(200)$$

$$\text{Plants}_{75} = 6200$$

This growth represents a simple rate of;

$$\frac{200}{6200} = .032 \text{ simple}$$

based on the assumption that the average new plant capacity is nearly the same as the existing plants

Ref 046 p 325 states that existing installations in Calif are on the order 100-150 T/hr whereas new sources may be on the order of 150-250 T/hr

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

P_c : cont'd

Assuming new plant size as 200 T/hr and existing plants at 150 T/hr then this would imply a simple growth rate of ;

$$\frac{200 \text{ plants} \times 200 \text{ T/hr}}{6200 \text{ plants} \times 150 \text{ T/hr}} = \frac{40 \times 10^3 \text{ T/hr}}{930 \times 10^3 \text{ T/hr}}$$

$$= .043 \text{ simple}$$

We see that the predicted growth of 10% is better than twice the calculated values based on specified plant additions

We assume that a growth rate of 5% simple to be representative of this industry for the period 1975 - 1985.

$$\therefore P_c = .05 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

A: Using the 6200 plants in 1975 and the 150 T/hr, 1600 $\frac{hr}{yr}$ operating mode for a typical asphalt batching plant (at capacity) then we may calculate A (1975 Production Capacity)

$$A = 6200 \text{ plants} \times 150 \frac{T/hr}{plant} \times 1600 \frac{hr}{yr}$$

$$A = 1480 \times 10^6 \ T/yr$$ asphalt mix produced

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Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

P_B :

Ref 044 pg 13 Tech. Report 6

50 obsolete plants will be replaced annually

The fifty plants that are replaced are assumed to be replaced with a total capacity equal to the obsolete capacity. This avoids the need to consider that the new plants replacing the obsolete plants will have a capacity greater than the existing

$$P_{B75} = \frac{50}{6200} = .00806$$

$$\boxed{P_B = .008 \text{ simple}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

The asphalt batching process involves the physical mixing of aggregate material (stone) with asphalt cement. Ref 177 pg 925 indicates that typical asphalt concrete is composed of 95% aggregate and 5% asphalt cement.

Ref 046 pg 326 describes the sources of particulate emissions

rotary drier
hot aggregate bucket elevator
vibrating screens
hot aggregate bins
weigh hopper
mixer

Ref 044 pg 9 states that NSPS for particulate, will limit total emissions from the above locations.

Ref 043 p121 ;

SO_2 emissions are attributable to burning high sulfur fuel oil

HC emissions are identified with the loading and mixing of asphalt cement in the final mixer.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

Particulates

E_u : The majority of emissions for asphalt batching plants are attributable to the rotary drier

Ref 075 Table 8.1-1

$$E_{uncontrolled} = 45 \text{ lb/TON asphalt}$$

$$E_{precleaner} = 15 \text{ lb/TON asphalt}$$

this source states that most plants have at least a precleaner (≈ 67% eff)

The~~se~~ emission is associated with the dryer and all secondary particulate sources. Since it is most common for the secondary sources to be vented and controlled along with the dryer exhaust then the 15 lb/ton factor is representative of typical asphalt plant employing a precleaning system.

Ref 046 p329 states that the usual primary collection device is a cyclone.

If the device is "dry" then the material captured may be added to the dryer hot aggregate and serve as fines.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-21-74

Source Asphalt Batching

Particulate

E_u : cont'd

We assume [redacted] the particulate emissions after precleaning to be the "uncontrolled" level for this industry since employment of some kind of device is S.O.P.

$$\boxed{\therefore E_u = 15 \text{ lb}/\text{TON asphalt concrete produced}}$$

E_N :

Wet scrubbers and fabric filters have both been mentioned (044, 046, 049, 043, 092, 177) as suitable control devices on asphalt concrete plants.

A control system for new plants would consist of a precleaner and one of the above as a secondary collector. Vents from the weigh hoppers, storage hoppers, mixer, elevator, and screens would be ducted along with the drier exhaust into the same control system.

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Computation Sheet For Emission Factors

Calculations Done By 2). Marrone Date 11-21-74

Source Asphalt Batching

Particulate cont'd

E_N :

Ref 075 Table 8.1-1 gives the overall efficiency attained by using various control systems in conjunction with a precleaner.

	lb/TON	Eff*
Multiple Centrifugal Scrubber	.3	99.3%
Baffle Spray Tower	.3	99.3%
Orifice-Type Scrubber	.04	99.9%
Baghouse	.1	99.8%
Properly Designed & Operated Control	.005-.02	99.96-99.99%

* based on totally uncontrolled emission of 45 lb/TON

Ref 044 pg 10

99.7% overall efficiency is necessary to meet proposed standard for asphalt concrete plants.

This is specified by a limit of .031 gr/dscf

While the new standard does specify an efficiency of 99.7% we see no reason why a level of 99.9% could not be specified in light of the above information. We assume 99.9% eff attainable for 1975-1985 $E_N = .001 \times 45 = .045$

$$\boxed{E_N = .045 \text{ lb/TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 4-28-75

Source Asphalt Batching

Particulate

E_s: We assume a typical plant size of 150 T/hr

This capacity rate refers to output however the product is composed of 95% aggregate and 5% asphalt which are both considered in the input process weight

Therefore $PWR = 150 \frac{T}{hr} \times 2000 \frac{lb}{T} = 300{,}000$ lb/hr (Ref 117 pg 925)

E_s will be determined for New and Existing plants with the condition that all new plants must have a limit at least as stringent as the NSPS value of .04 gr/dscf (Ref 271)

Ref 144 pg 10 suggests a control efficiency 99.7% to meet the then proposed limit of .031 gr/dscf

We may develop the following equivalent emission factors from promulgated & proposed standards background information

promulgate NSPS equivalent factors

① $\boxed{.04 \text{ gr/dscf}}$

② $\frac{.04}{.031} \times .003 = .00387 \Rightarrow \approx 99.6\%$ eff

.[illegible] × 45 lb/TON = $\boxed{.175 \text{ lb/TON}}$

③ $.175 \frac{lb}{TON} \times 150 \frac{TON}{hr} = \boxed{26.25 \text{ lb/hr}}$

Emission limitations are compiled for each state based on Ref 084 & 148 and the above information. pg 7 & 8 give limits in lb/hr for existing and new plants.

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 11-22-74

Source Asphalt Batching

Particulate E_S: cont'd

Determination of typical flue gas volume rate

Ref 046 pg 328 based on two tests

	lb/hr Process	T/hr	SCFM (TOTAL)	SCFM/T/hr
Test #1 (C-426)	364,000	182.	23,800	130.8
Test #2 (C-537)	346,000	173	25,765	148.9

Avg ≈ 140 $\frac{\text{scfm}}{\text{T/hr}}$

$$\text{SCFM}_{150\,\text{T/hr}} = 140\ \frac{\text{SCFM}}{\text{T/hr}} \times 150\ \text{T/hr}$$

$$\text{SCFM}_{150\,\text{T/hr}} = 21{,}000$$

using a density at standard conditions of .075 lb/SCF we may calculate the approximate mass flow of exhaust gas.

$$21{,}000\ \frac{\text{SCF}}{\text{MIN}} \times 60\ \frac{\text{min}}{\text{hr}} \times .075\ \frac{\text{lb}}{\text{SCF}} = 94{,}500\ \frac{\text{lb}}{\text{hr}}\ \text{exhaust gases}$$

for typical
150 T/hr asphalt
batching plant

Asphalt Batching

E_s Determination
(Particulates)

Based on 150 T/hr or 300,000 lb/hr
process weight

	Allowable lb/hr	
	Existing	New
Alabama	55**	26.25*
Alaska	180+	26.25*
Arizona	55**	26.25*
Arkansas	100	26.25***
Colorado	39**	26.25*
Calif.	40**	26.25*
Conn	28.35+	26.25***
Delaware	40	26.25***
D.C.	40**	26.25*
Florida	40**	26.25*
Georgia	74.2	26.25***
Hawaii	40**	26.25*
Idaho	55	26.25*
Illinois	36**	26.25*
Indiana	55**	26.25*
Iowa	27+	26.25***
Kansas	55**	26.25*
Kentucky	55**	26.25*
Louisiana	55**	26.25*
Maine	40**	26.25*
Maryland	55**	26.25*
Mass	13.4	6.7
Michigan	28.35+	26.25***
Minn	55**	26.25*
Miss	107**	26.25*
Missouri	55**	26.25*
Montana	55**	26.25*
Nebraska	40**	26.25*
Nevada	55**	26.25*
N. Hamp	40	26.25***
N. Jersey	30	26.25*
N. Mexico	40	26.25***
N. York	59**	26.25*
N. Carolina	42	26.25***
N. Dakota	55**	26.25

Asphalt Batching
E_3 cont'd
(Particulate)

	Allowable lb/..	
	Existing	New
Ohio	55**	26.25*
Okla	40	26.25***
Oregon	40	26.25***
Penn	3.6	3.6
R.I	55**	26.25*
S. Carolina	67	26.25***
S. Dakota	55**	26.25*
Tenn	51.2	26.25***
Texas	105**	26.25*
Utah	337 ++	26.25*
Vermont	40**	26.25*
Virginia	40	26.25***
Wash	40	26.25***
W. Vir	40	26.25***
Wisconsin	28.35+	26.25***
Wyoming	40**	26.25*

* No Reg for New Source — NSPS assumed

** No Reg for existing Source (Asphalt Batch)
Process Weight Rate Curve used with
300,000 lb/hr PWR

*** $E_3(\text{New}) > \text{NSPS} \quad \therefore E_3(\text{New}) = \text{NSPS}$

+ based on 21,000 scfm for 150 T/hr plant

++ 85% control required on uncontrolled emissions

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 6-9-75

Source Asphalt Batching

Particulate

E_s:

$$E_s = \frac{\sum_{1}^{51} E_{si}}{51}$$

Distribution of capacity, by state was not obtained however, all will have process. We assume that average of E_{si} will approximate well the typical E_s.

$$E_{s_{new}} = \frac{\sum E_{si}}{51} = \frac{1296.25}{51} = 25.41 \text{ lb/hr}$$

$$E_{s_{existing}} = \frac{\sum E_{si}}{51} = \frac{2876.45}{51} = 56.40 \text{ lb/hr}$$

applying the plant size. for this process weight rate (150 T/hr) we obtain;

$$E_{s(new)} = \frac{25.41}{150} = .169 \text{ lb/TON asphalt concrete}$$

$$E_{s(existing)} = \frac{56.40}{150} = .376 \text{ lb/TON asphalt concrete}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W Marrone Date 11-22-74

Source Asphalt Batching

Hydrocarbons

E_u : As mentioned 043 pg 121 indicates the loading and mixing of asphalt cement in the mixer is the source of hydrocarbons.

Emission data for this pollutant from asphalt batching was not found in the literature. We make the assumption however, that hydrocarbon emissions may be approximated by applying factors for coating of asphalt to roofing material

Ref 075 Table 8.2-1

Using Spraying & Dipping factor of 2 lb/TON saturated felt and estimate (bottom of Table) that 65% of felt weight is asphalt

$$E = \frac{2\text{ lb}}{\text{TON Felt Sat}} \times \frac{\text{TON Felt Sat}}{.65\text{ TON Asphalt Used}} = 3.33\,\frac{\text{lb}}{\text{TON Asphalt used}}$$

For a typical Asphalt Batching Plant of 150 T/hr with 5% of concrete composed of asphalt cement

$$150\,\frac{\text{TON}}{\text{hr}} \times .05 = 7.5\,\frac{\text{T}}{\text{hr}}\text{ asphalt used}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-22-74

Source Asphalt Batching

Hydrocarbons cont'd

E_u :

$$\text{Emission} = \frac{3.33 \frac{\text{lb HC}}{\text{TON Asphalt}} \times 7.5 \frac{\text{TON Asphalt}}{\text{hr}}}{150 \frac{\text{TON}}{\text{hr}} \text{ Asphalt concrete}}$$

$$\therefore \boxed{E_u = .167 \text{ lb/TON Asphalt concrete}}$$

hydrocarbon emissions from the mixer, while vented to the primary and secondary control devices, are not expected to be controlled appreciably especially if water scrubbers and baghouses are employed.

Ref 043 pg 122 state "the hydrocarbon emission problem is a difficult one that can really only be handled by thermal incineration. However this technique is not frequently used: The primary method of control is to maintain a tight enclosure of the mixer".

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

Hydrocarbons contd

E_N: It is our assessment that while particulates may be controlled successfully be the two-stage control system, hydrocarbon emissions are not eliminated and no feasible system has been proven.

We will assume $E_N = 0$ for maximum impact to flag this industry as in potential need of control technology..

$$\boxed{E_N = 0} \text{ MAX IMPACT}$$

E_S: Hydrocarbon emission regulations do not apply to this type of source so E_S is assumed equal to E_u

$$\boxed{E_S = .167 \ \frac{\text{lb}}{\text{TON}} \text{ Asphalt Concrete}}$$

Project Number - 32391 **New Source Performance Standards**

Computation Sheet For **Emission Factors**

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

SO_x

E_u: Ref 043 pg 121 suggests that SO_2 emissions are attributable to combustion of high sulfur fuel oil in the drier and heaters. The two fuels normally employed are natural gas and fuel oil (No. 6) Ref 046 pg 326 reports operating temperature for drier of 250 - 350°F

We do not know the % breakdown of driers using oil and those using gas. We assume for the purpose of this study a 50% split. The sulfur content of the natural gas is considered negligible. Ref 022 Table 4-2 %S of Residual oil 1.5%S

Using 21,000 SCFM for 150 $\frac{T}{hr}$ asphalt concrete plant and drier temp of 300°F we will obtain an estimate for emissions of SO_x from fuel oil combustion

$$Q = \omega C_p \Delta T \qquad \text{assume } T_1 = 70°F$$

ω = lbmoles of air

$C_p = 7 \frac{BTU}{lbmole\ °F}$

$\Delta T = T_2 - T_1 = 300°F - 70°F = 230°F$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

SO_x / E_u cont'd

Ref 143 Sec F-147

$$W = 21{,}000 \frac{\text{scF}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \times .075 \frac{\text{lb}}{\text{scF}} \times \frac{1 \text{ lb mole air}}{28.96 \text{ lb}}$$

$$W = 3263 \frac{\text{lbmole}}{\text{hr}} \text{ air}$$

$$\text{Heat requirement} = Q = 3{,}263 \frac{\text{lbmole}}{\text{hr}} \times \frac{7 \text{BTU}}{\text{lbmole}\,^\circ\text{F}} \times 230^\circ\text{F}$$

$$Q \cong 5.25 \times 10^6 \frac{\text{BTU}}{\text{hr}}$$

Ref 101 Table 9-9

For NO 6 oil 7.998 - 8.108 lb/gal

150,700 - 152,000 BTU/gal

using 8 lb/gal and 151,350 $\frac{\text{BTU}}{\text{gal}}$

$$\frac{151{,}350}{8} = 18{,}919 \text{ BTU/lb}$$

Fuel rate requirement:

$$\frac{5.25 \times 10^6 \frac{\text{BTU}}{\text{hr}}}{1.8919 \times 10^4 \frac{\text{BTU}}{\text{lb}}} = 2.77 \times 10^2 \frac{\text{lb oil}}{\text{hr}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

SO_x cont'd

E_u:

$$\therefore\ 277\ \frac{lb}{hr}\ \text{fuel oil}$$

with the assumption that all sulfur is emitted and in the from SO_2 we obtain;

$$277\ \frac{lb\ oil}{hr} \times .015 \times 2\ \frac{lb\ SO_2}{lb\ S} = 8.31\ lb\ SO_2/hr$$

and

$$\frac{8.31\ lb\ SO_2/hr}{150\ Ton/hr} = .055\ lb\ SO_2/\text{TON Asphalt Concrete}$$

this also represents $\frac{8.31}{5.25}\ \frac{lb\ SO_2/hr}{10^6\ BTU/hr} = 1.58\ lb\ SO_2/10^6\ BTU$

We may also calculate the emissions from nat gas fuel combustion

$$Q = 5.25 \times 10^6\ BTU/hr$$

Ref 075 pg 1.4-1 $BTU/ft^3 = 1050$

$grain\ S/10^6\ ft^3 = 2000$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By RJ. Marrone Date 11-22-74

Source Asphalt Batching

SO_x / E_u cont'd

$$5.25 \times 10^6 \frac{BTU}{hr} \times \frac{ft^3}{1050\ BTU} \times \frac{2000\ grain\ S}{10^6\ ft^3} \times \frac{lb\ S}{7000\ grain\ S} \times \frac{2\ lb\ SO_2}{1\ lb\ S}$$

$$E \cong .0029\ lb\ SO_2/hr$$

and

$$\frac{.0029\ lb\ SO_2/hr}{150\ TON/hr} = .000019\ lb\ SO_2/TON \text{ Asphalt concrete}$$

$$\text{or } \frac{.0029\ lb\ SO_2/hr}{5.25 \times 10^6\ BTU/hr} = .00055\ lb\ SO_2/10^6\ BTU$$

The actual emissions from this industrial source, assuming a 50% - 50% split for fuel usage is calculated by.

$$\overset{\text{Nat Gas}}{.5\left(.000019\ \frac{lb\ SO_2}{TON}\right)} + \overset{\text{Oil}}{.5\left(.055\ \frac{lb\ SO_2}{TON}\right)} = \overset{\text{negligible}}{\overset{\downarrow}{.0000095}} + .0275$$

$$\approx .0275$$

$$\boxed{E_u = .0275\ lb\ SO_2/TON \text{ asphalt concrete}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

SO_x / E_N:

Add-on control systems are not amenable to this type of source for SO_x emissions. Fuel switching is a feasible scheme. It is assumed that .5% S may be substituted for NO. 6 residual fuel oil. It is conceivable that any sulfur content may be proposed or a switch specified to Natural gas only however, it is reasonable to assume that economics and fuel availability will affect these alternatives. Our assumption of .5% S fuel oil and maintanence of the 50% - 50% split in natural gas & fuel oil is considered a reasonable assumption.

$$E = .5 \times 0 \frac{lb}{TON} + .5 \times \left(\frac{.055}{2} \right)$$

$$\boxed{E_N = .0138 \ lb/TON}$$ Asphalt concrete

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

SOx / $E_{s_{oil}}$: The allowable emissions for existing and new sources will be synthesized from the attached tabular data. The following assumptions were made.

① where ground level conc were stated we assumed this state to have average SO_2 limitation ∴ (5 states plus 1 state existing)

② where no reg appears $E_{s_i} = E_u = 1.58$ lb SO_2 / 10^6 BTU

③ Louisiana and California is assumed to have an average limitation

$$E_s = \frac{\sum_{i=1}^{n} E_{s_i}}{n}$$

we make the assumption that the asphalt batching capacity is distributed equally throughout states; distribution was not found in literature.

E_s (existing):

$$6 \cdot E_u + 59.16 = \frac{9.48 + 59.16}{37+6} = \frac{68.64}{43}$$

$$E_s \text{(existing)} = 1.596 \text{ lb } SO_2 / 10^6 \text{ BTU}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 11-22-74

Source Asphalt Batching

$SO_x / E_{S_{oil}}$ cont'd

E_s (NOW)

$$6 \times E_u + 54.71 = \frac{9.48 + 54.71}{6 + 38} = \frac{64.19}{44}$$

$$E_{s\,(NOW)} \cong 1.46 \text{ lb } SO_2 / 10^6 \text{ BTU}$$

Since E_s existing $> E_u$ we assign E_s existing $= E_u = 1.58$ lb $SO_2/10^6$ BTU

$= .055$ lb SO_2/TON

$$E_{s\,(new)} = 1.46 \text{ lb } SO_2 / 10^6 \text{ BTU}$$

Using 5.25×10^6 BTU/hr. for a 150 T/hr plant we may convert these values of E_s to lb/TON

$$E_{s\,(new)} = .051 \text{ lb } SO_2/\text{TON}$$

E_s: Gas

The allowable emission from natural gas combustion is assumed equal to E_u

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 11-22-74

Source Asphalt Batching

SO_x / E_s

We calculate the allowable emissions as follows with 50-50 split

$$E_s \text{ (existing)} \quad .5 \times \left(\overset{\text{Nat Gas}}{.000019} \frac{\text{lb SO}_2}{\text{TON}}\right) + .5\left(\overset{\text{Oil}}{.055} \frac{\text{lb SO}_2}{\text{TON}}\right) \approx .0275 \frac{\text{lb SO}_2}{\text{TON}}$$

$$\boxed{E_s \text{ (existing)} = .0275 \frac{\text{lb SO}_2}{\text{TON asphalt concrete}}}$$

$$E_s \text{ (New)} \quad .5 \cdot \left(\overset{\text{Nat Gas}}{.000019} \frac{\text{lb SO}_2}{\text{TON}}\right) + .5\left(\overset{\text{oil}}{.051} \frac{\text{lb SO}_2}{\text{TON}}\right) \approx .0255 \frac{\text{lb SO}_2}{\text{TON}}$$

$$\boxed{E_s \text{ (New)} = .0255 \frac{\text{lb SO}_2}{\text{TON asphalt concrete}}}$$

Asphalt Batching

SO_2 Allowable Emissions

$< 10 \times 10^6$ BTU/HR
Fuel Burning equipment

	% S limitation Oil		lb SO_2/10^6 BTU	
	Existing	New	Existing	New
Alabama			1.35^{*}	1.2
Alaska			1.0	1.0
Arizona			**	**
Arkansas			**	**
Colorado			.3	.3
California			+	+
Conn.	.5	.5	.55	.55
Delaware	.3	.3	$.33^{++}$	$.33^{++}$
D.C.	.5	.5	$.55^{++}$	$.55^{++}$
Florida			⊖	⊖
Georgia	2.5	2.5	2.75^{++}	2.75^{++}
Hawaii	2.0	2.0	2.2^{++}	2.2^{++}
Idaho	.3	.3	$.33^{++}$	$.33^{++}$
Illinois			1.0	1.0
Indiana			1.2	1.2
Iowa			1.5	1.5
Kansas			⊖	⊖
Kentucky			2.5	2.5
Louisiana			Δ	Δ
Maine	2.5	2.5	2.75^{++}	2.75^{++}
Maryland	.5	.5	$.55^{++}$	$.55^{++}$
Mass.			1.1	1.1
Michigan			⊖	⊖
Minn.	2.0	2.0	2.2^{++}	2.2^{++}
Miss.			4.8	2.4
Missouri			2.0	.5
Montana			2.0	2.0
Nebraska			**	**
Nevada			2.0	2.0
N. Hampshire	1.0	1.0	1.1^{++}	1.1^{++}
N. Jersey			.3	.3
N. Mexico			⊖	⊖
New York			.4	.4
N. Carolina			2.3	1.6
N. Dakota			3.0	3.0
Ohio			1.9^{*}	1.9^{*}

	% S limitation – oil		$lb\ SO_2/10^6$ BTU	
	Existing	New	Existing	New
Oklahoma			**	.3
Oregon			1.4	1.4
Penn.			2.0*	2.0*
R.I.	1.0	1.0	1.1 ++	1.1 ++
. Carolina			1.6	1.6
. Dakota			3.0	3.0
Tennessee	2.0	2.0	2.2 ++	2.2 ++
Texas			**	**
Utah	1.5	1.5	1.65 ++	1.65 ++
Vermont	1.0	1.0	1.1 ++	1.1 ++
Virginia			**	**
Washington			1.5	1.5
W. Virginia	1.5	1.5	1.65 ++	1.65 ++
Wisconsin			⊖	⊖
Wyoming			⊖	⊖

Ref 148 & 084

* Average of data appearing

** ground level conc specified

+ Reg stated for county only

++ $lb\ SO_2/10^6$ BTU calc from sulfur content using Conn as ref $\frac{.55}{.5} = 1.1$ ratio

⊖ No reg

Δ stack ppm stated

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 11-26-74

Source Asphalt Roofing

K:

Capacity data for this particular industry was not presented so as to be compared with production data. Therefore a true capacity utilization factor will be estimated otherwise.

The asphalt roofing manufacturing operation is a continuous operation. We make the assumption that the value of K may be approximated by considering it to be similar in operation to Paper Processing. Ref 144 pg 48 give an average value of K for the period 1965 - 1973 for the Paper Processing Industry of .91. Our estimate of K for Asphalt roofing plants will be K = .90

$K = .90$

same for
asphalt "blowing"
asphalt saturator

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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 11-26-74

Source Asphalt Roofing

P_c :

The growth in this industry is reported in Ref 021 pg 1-1 to be about 2.75 %/yr

This is based on a "simple" growth projection from shipment data during the period 1963-1971 Table 1-1

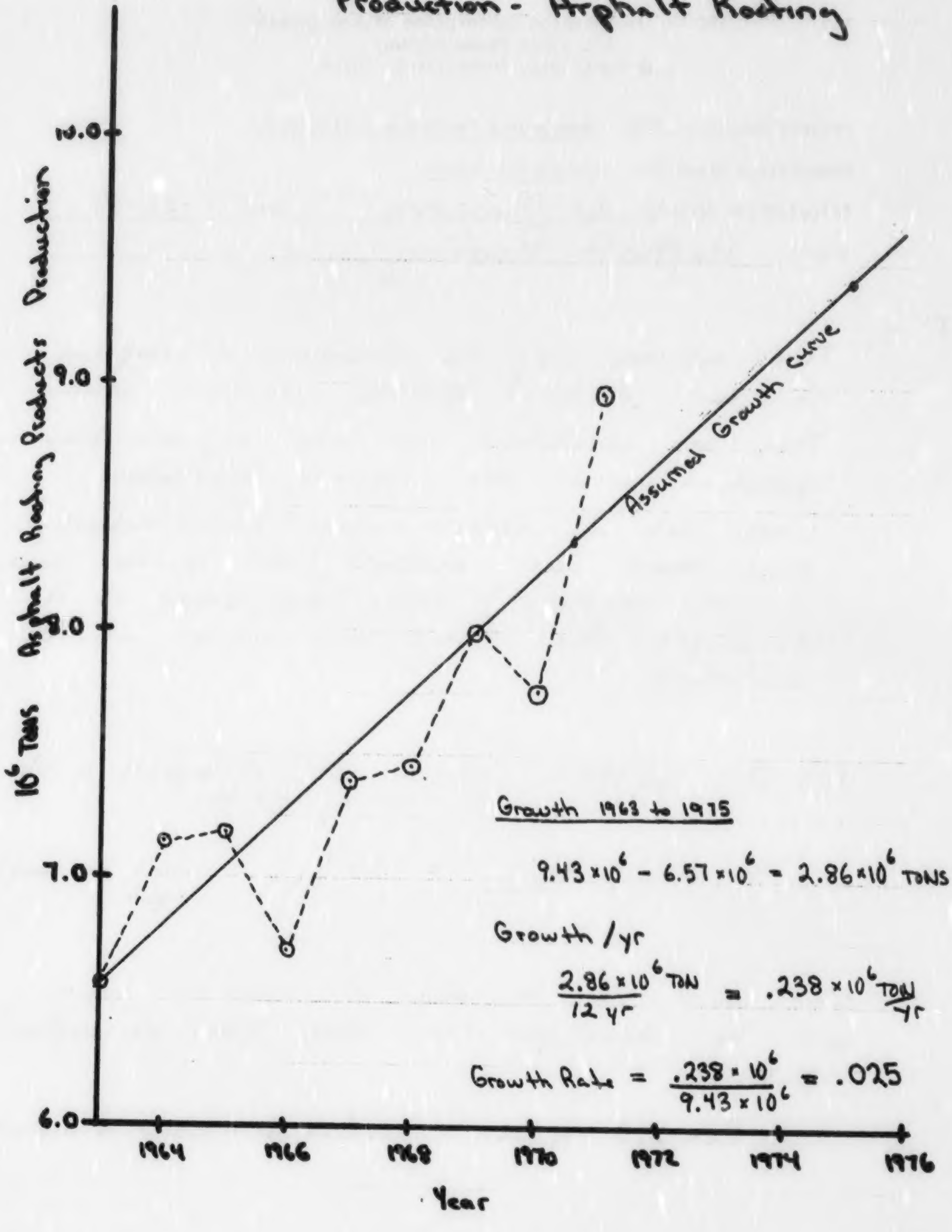
We will replot this data and determine the actual growth (simple also) however, based on the year 1975. It is not clear whether ref 021 did use 1975 as a base line or not.

Based on the development on the attached graph we estimate a 2.5% growth (simple) in the production of asphalt products

$$P_c = .025 \text{ simple}$$

same for asphalt "blowing" and asphalt saturator

Production - Asphalt Roofing



Growth 1963 to 1975

$9.43\times10^6 - 6.57\times10^6 = 2.86\times10^6$ TONS

Growth / yr

$$\frac{2.86\times10^6\ \text{TON}}{12\ \text{yr}} = .238\times10^6\ \frac{\text{TON}}{\text{yr}}$$

$$\text{Growth Rate} = \frac{.238\times10^6}{9.43\times10^6} = .025$$

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Source Asphalt Roofing

A : This industry may be considered as composed of two distinct "primary" pollutant sources. They are identified as the asphalt blowing operation and the asphalt saturator. Since, not all asphalt roofing plants actually blow their own asphalt (this is often done at the refinery.) then the value of A developed for these two sources will be different.

Ref 047 pg 159 estimates 50% of asphalt is blown in roofing plants.

therefore $A_{blowing} = .5 \times A_{sat}$ based on asphalt input.

Our value of A and all emission figures will be developed on the basis of asphalt input.

Ref 075 pg 8.2-1 60% of felt product is asphalt

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Source Asphalt Roofing

A:

From attached graph of production we may obtain the 1975 estimated production of asphalt roofing products

$$P_{75} = 9.43 \times 10^6 \text{ TONS/yr}$$

if K = .9 and 60% of product is asphalt then the asphalt input capacity for this industry is calculated;

$$\frac{9.43 \times 10^6 \frac{\text{TON}}{\text{yr}} \text{Product} \times \frac{.6 \text{ TON Asphalt}}{\text{TON Product}}}{.9}$$

$$\boxed{A_{\text{Saturator}} = 6.29 \times 10^6 \frac{\text{TONS}}{\text{yr}} \text{ asphalt input}}$$

with only 50% of asphalt "blown" at the roofing plant;

$$\boxed{A_{\text{blowing}} \cong 3.15 \times 10^6 \text{ TON/yr asphalt input}}$$

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Source Asphalt Batching

P_B :

A specific category relative to asphalt roofing plants was not found in the IRS Depreciation Guidelines Ref 037. We make the assumption that this activity however may be considered similarly with that covered under Section 26.2 pg 32-33 of Ref 037. This category describes the asset guideline period for equipment used in the production of converted products such as coated paper.

Asset Guideline period = 12 yrs

P_B est → 2×IRS = 24 yrs

$$\frac{100\% \text{ depreciation}}{24 \text{ yrs}} \cong 4.2\%/\text{yr simple}$$

$$\boxed{P_B = .042 \text{ simple}}$$

Same for asphalt "blowing" & asphalt saturator

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Computation Sheet For Emission Factors

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Source Asphalt Roofing

Blowing:

E_u: Ref 075 Table 8.2-1

$$E_{u_p} = 2.5 \text{ lb Part}/\text{TON Sat Felt}$$

$$E_{u_{HC}} = 1.5 \text{ lb HC}/\text{TON Sat Felt}$$

$$E_{u_{CO}} = .9 \text{ lb CO}/\text{TON Sat Felt}$$

converting this to asphalt input (60% of sat felt is asphalt) which is assumed equal to asphalt blown

$$E_u(\text{part}) = 2.5 \frac{\text{lb P}}{\text{TON Felt}} \cdot \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} \cong 4.2 \text{ lb}/\text{TON Asphalt blown}$$

$$E_u(\text{HC}) = 1.5 \frac{\text{lb HC}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} = 2.5 \text{ lb}/\text{TON Asphalt blown}$$

$$E_u(\text{CO}) = .9 \frac{\text{lb CO}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON asphalt}} = 1.5 \text{ lb}/\text{TON asphalt blown}$$

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Source Asphalt Roofing

Blowing: cont'd

E_N

Ref 021 Table 6-3 specifies 99% control efficiency on asphalt blowing operation using an afterburner. We assume that design would incorporate control of all three pollutants (Part, HC, and CO)

$$\therefore \quad E_N = .01 \times E_u$$

$$\therefore \quad E_N(\text{Part}) = .01 \times 4.2 = .042 \text{ lb/TON asphalt blown}$$

$$E_N(\text{HC}) = .01 \times 2.5 = .025 \text{ lb/TON asphalt blown}$$

$$E_N(\text{CO}) = .01 \times 1.5 = .015 \text{ lb/TON asphalt blown}$$

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Computation Sheet For Emission Factors

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Source Asphalt Roofing

Blowing:

E_s : regulations for HC and CO are not applicable to asphalt roofing plants
Ref 148 & 084

$$\therefore E_s = E_u$$

Hydrocarbons $E_s(HC) = 2.5$ lb/TON Asphalt blown

Carbon Monoxides $E_s(CO) = 1.5$ lb/TON Asphalt blown

Particulates

Using 50 TPH as a typical plant size
Ref 021 pg 2-9 Table 2.1

$$50 \frac{\text{TON}}{\text{HR}} \text{ asphalt prod} \times \frac{.6 \text{ TON asphalt}}{\text{TON asphalt prod.}} = 30 \frac{\text{TON}}{\text{hr}} \text{ asphalt}$$

assuming all asphalt input is blown then the process weight for the blowing operation is $30 \frac{\text{TON}}{\text{hr}}$ ($60{,}000 \frac{\text{lb}}{\text{hr}}$)

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Source Asphalt Roofing

Blowing:

E_s cont'd

From Ref H8 & 084 Generalized process weight rate curve for particulates

Process weight rate = 60,000 lb/hr

Allowable emission = 35.5 lb/hr

$$E_s = \frac{35.5 \text{ lb/hr}}{30 \text{ TON/hr}} = 1.18 \frac{\text{lb Part}}{\text{TON asphalt blown}}$$

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Source Asphalt Roofing

Saturator:

Ref 075 Table 8.2-1

E_4

Emissions from the saturator are identified as particulates however as discussed in Ref 021 pg 2-4 they are in actuality hydrocarbon droplets (vapor mist)

We use the emission for spraying and dipping as typical

$$E = 2\,\frac{\text{lb}}{\text{TON Sat Felt}} \times \frac{1\ \text{TON Sat Felt}}{.6\ \text{TON asphalt}}$$

$$\therefore\ E = 3.33\ \text{lb Part}/\text{TON asphalt input}$$

From Ref 021 pg 2-4

① 45 lb/hr HC 16,500 lb/hr felt

$$\frac{45\ \frac{\text{lb HC}}{\text{hr}}}{16{,}500\ \frac{\text{lb Sat}}{\text{hr}}} \times \frac{\text{TON felt}}{2000\ \text{lb}} = 5.45\ \text{lb}/\text{TON Felt}$$

$$\frac{5.45\ \text{lb}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6\ \text{Asphalt}} \cong 9.1\ \text{lb}/\text{TON asphalt input}$$

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Source Asphalt Roofing

Saturator :

E_u cont'd

Ref 021 pg 2-4

③ 23-69 lb/hr HC avg 46 lb/hr (assume hydrocarbon emission to be in mist form ie. particulate)

$$\frac{46 \frac{\text{lb}}{\text{hr}}}{16{,}000 \frac{\text{lb felt}}{\text{hr}} \times \frac{\text{TON}}{2000 \text{ lb}}} = 5.75 \text{ lb/TON felt}$$

$$5.75 \frac{\text{lb}}{\text{TON Felt}} \times \frac{\text{TON Felt}}{.6 \text{ TON Asphalt}} \cong 9.6 \text{ lb/TON asphalt input}$$

We estimate E_u from the average of these three factors,

$$E_u \cong \frac{(3.33 + 9.1 + 9.6)}{3} \text{ lb/TON asphalt input}$$

$$\therefore E_u = 7.3 \text{ lb Part/TON asphalt input}$$

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Computation Sheet For Emission Factors

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Source Asphalt Roofing

Saturator :

E_N Ref 021 pg 6-7 Table 6.3

Control efficiency with Afterburner on new asphalt roofing saturator 99%

$$\therefore E_N = .01 \times E_u = .01 \times 7.3 \text{ lb/TON}$$

$$\therefore E_N = .073 \text{ lb/TON asphalt input}$$

E_S :

Using, as before, 50 TPH as a typical process capacity.

$$50 \frac{\text{TON sat felt}}{\text{hr}} = 100{,}000 \frac{\text{lb sat felt}}{\text{hr}}$$

This weight is considered the process weight rate and from the Generalized Weight Rate Curve the allowable emission is 40 lb/hr

$$E_s = \frac{40 \text{ lb/hr}}{50 \frac{\text{TON sat felt}}{\text{hr}}} \times \frac{1}{\frac{.6 \text{ TON asphalt}}{\text{TON sat felt}}} = 1.33 \frac{\text{lb}}{\text{TON asphalt input}}$$

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Computation Sheet For Emission Factors

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Source Asphalt Roofing

Summary of Emission Factors

lb/ton asphalt input

	Particulate			Hydrocarbon			Carbon Monoxide		
	E_u	E_s	E_N	E_u	E_s	E_N	E_u	E_s	E_N
Asphalt Blowing	4.2	1.18	.042	2.5	2.5	.025	1.5	1.5	.015
Asphalt Saturator	7.3	1.33	.073	/	/	/	/	/	/

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-6-74

Source Concrete Batching

Ref 146 p 38 states that about 63% of all cement plant product (portland cement) is consumed by the redi-mix concrete industry.

From data in ref 215 (1974 edition) pg 275-278 we estimate that in 1972 ≈ 65% of cement production went to redi-mix concrete plants.

We assume a value of 65% to be representative of the percentage of cement production to the concrete batching industry during the period 1975 - 1985.

Ref 146 pg 39 also states that the concrete industry should be in a good position to maintan a good supply of cement since they have been the formers most regular and largest customers.

Using the 1975 production estimate of portland cement (pg 2 of Portland Cement Industrial Factors)

$$492 \times 10^6 \ \frac{\text{bbl cement}}{\text{yr}} \qquad \text{and} \quad 1 \ \text{bbl cement} = 376 \ \text{lb}$$

$$P_{75}(\text{cement}) = 492 \times 10^6 \ \frac{\text{bbl}}{\text{yr}} \times \frac{376 \ \text{lb}}{\text{bbl}} \times \frac{\text{TON}}{2000 \ \text{lb}}$$

$$= 92.5 \times 10^6 \ \text{TON/yr}$$

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Computation Sheet For Industrial Factors

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Source Concrete Batching

With the assumption of 65% of cement production going to concrete batching industry

$$.65 \times 92.5 \times 10^6 \ \frac{\text{TON}}{\text{yr}}$$

$$\begin{matrix}\text{Cement to} \\ \text{Concrete Plants}\end{matrix} = 60.1 \times 10^6 \ \frac{\text{TON}}{\text{yr}} \text{ cement}$$

Ref 075 Table 8.10-1 Note ⓐ 735 lb cement / yd^3 concrete
4000 lb concrete / yd^3 concrete

$$\frac{735}{4000} \cong .184 \ \frac{\text{lb cement}}{\text{lb concrete}} \quad \text{or} \quad \frac{\text{TON}}{\text{TON}}$$

We may then calculate the concrete production in 1975

$$\text{Concrete } P_{75} = 60.1 \times 10^6 \ \frac{\text{TON}}{\text{yr}} \text{ cement} \times \frac{\text{TON concrete}}{.184 \text{ TON cement}}$$

$$P_{75} = 326.6 \times 10^6 \ \frac{\text{TON}}{\text{yr}} \text{ concrete}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-6-74

Source Concrete Batching

K : Since the figure developed for concrete production is based on cement input (as supplied by portland cement plant) then the value of K is considered equal to one. It does not refer to true capacity utilization

$$K = 1.0$$

A : Since $K = 1$ $A = P_{75} = 326.6 \times 10^6 \frac{\text{TON}}{\text{yr}}$ concrete

$$\boxed{A = 326.6 \times 10^6 \frac{\text{TON}}{\text{yr}} \text{ concrete}}$$

P_c : By assuming that 65% of cement production during the period 1975 to 1985 goes to the concrete batching industry this inherently implies that the growth in concrete batching will mirror the Portland Cement industry

$$\therefore P_c = .03 \text{ compound}$$

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Source Concrete Batching

P_B :

Ref 037 Class 32.3

Asset Guideline period 15 yrs

P_B est → 2 × IRS = 30 yrs

$\frac{100\% \text{ depreciation}}{30 \text{ yrs}} = 3.33\%/\text{yr}$ simple

$\therefore P_B = .033$ simple

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Source Concrete Batching

Particulate

E_u: Ref 075 Table 8.10-1

Uncontrolled Plant $.2 \frac{\text{lb}}{\text{yd}^3_{\text{concrete}}}$

using $4000 \frac{\text{lb}}{\text{yd}^3}$ typical of concrete

$$E = .2 \frac{\text{lb}}{\text{yd}^3} \times \frac{\text{yd}^3}{4000 \text{ lb}} \times \frac{2000 \text{ lb}}{\text{TON}} = .1 \text{ lb}/\text{TON}$$

$$\therefore \boxed{E_u = .1 \text{ lb}/\text{TON concrete}}$$

E_N: Ref 075 Table 8.10-1

Good controlled plant } enclosure of dumping & loading areas, conveyors and elevators, control of storage bins with filters, use of water sprays

$.02 \text{ lb}/\text{yd}^3$

then $E = .02 \frac{\text{lb}}{\text{yd}^3} \times \frac{\text{yd}^3}{4000 \text{lb}} \times \frac{2000 \text{lb}}{\text{TON}} = .01 \text{ lb}/\text{TON concrete}$

$$\therefore \boxed{E_N = .01 \text{ lb}/\text{TON}}$$

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Computation Sheet For Emission Factors

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Source Concrete Batching

cont'd

E_S :

Ref 146 pg 39

Redimix concrete plants - 5000

Ref 217 pg 6-228 Table 8

We assume air-entrained concrete with typical water usage of 34 gal/yd³ concrete.

$$34 \frac{\text{Gal}}{\text{yd}^3 \text{ concrete}} \times 8.346 \frac{\text{lb } H_2O}{\text{Gal}} \times \frac{\text{yd}^3}{4000 \text{ lb concrete}} = .071 \frac{\text{lb } H_2O}{\text{lb concrete}}$$

or 7.1% water in concrete

or 142 lb H_2O/TON concrete

Average Plant size based on capacity $= 326.6 \times 10^6 \frac{\text{TON concrete}}{\text{yr}} \Big/ 5000$

$= 65{,}320$ TON concrete/yr per plant

Assumed operating schedule $8 \frac{\text{hr}}{\text{d}} \times \frac{5\text{ d}}{\text{wk}} \times 45 \frac{\text{hr}}{\text{yr}} = 1800 \frac{\text{hr}}{\text{yr}}$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74

Source Concrete Batching

Particulates cont'd

E_s :

Process weight rate calc

65,320 TON/yr

7.1% water (not included in process weight)

1800 hr/yr operation

$$PWR = 65{,}320 \frac{\cancel{TON}}{\cancel{yr}} \times \frac{\cancel{yr}}{1800\ hr} \times 2000 \frac{lb}{\cancel{TON}} \times .929$$

$$PWR \equiv 67{,}425\ lb/hr \text{ input } \left(33.7 \frac{TON}{hr}\right)$$

Ref 084 & 148

Only Conn, Ind., Virgina, and S.C have regulation applicable to concrete batching plants

Conn: $E_{si} = .02$ lb/yd³ or $E_{si} = .01$ lb/TON concrete

Virginia: $E_{si} = 1.13$ lb/TON concrete since $E_{si} > E_u$ we assume $E_{si} = E_u = .1 \frac{lb}{TON}$

S.C: $E_{si} = .85$ lb/TON concrete since $E_{si} > E_u$ we assume $E_{si} = E_u = .1 \frac{lb}{TON}$

Ind: by process curve $E_{si} = 2.4 \frac{lb}{TON}$ since $E_{si} > E_u$ we assume $E_{si} = E_u = .1 \frac{lb}{TON}$

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Source Concrete Batching

E_s: Particulate cont'd

For the remaining states in which specific regulation applicable to concrete batching do not exist we determine the allowable emission based on the Generalized Process Weight Rate Curve.

From PWR Curver 36.5 lb/hr
Ref 014 p. 148

$$\frac{36.5\frac{lb}{hr} \times 1800\,hr}{65,320\,\frac{TON}{yr}} \cong 1\ lb/TON$$

since $E_{si} > E_u$ we assume $E_{si} = E_u = .1$ lb/TON

We see that only one state (Conn) appears to require control more stringent than E_u. We will estimate E_s by weighting the allowable emission thus;

$\frac{1}{50}$ or 2% of states require .01 lb/TON

$\frac{49}{50}$ or 98% of states require .1 lb/TON

$$E_s = .98(.1) + .02(.01)$$

$$E_s = .098 + .0002 = .0982$$

$$\therefore E_s = .098\ lb/TON\ concrete$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

K:

Overcapacity plagued this industry during the 1960's when capacity utilization was between 75-80%.

Ref 146 p 36

K in 1970	88.4%
K " 1971	87.7%
K in 1972	> 90%

Ref 125 pg6 states that the current rate is 85% and that maximum profits are realized at 85-90% utilization.

We assume a rate of 90% as reasonable for the period 1975 - 1985.

K = .90

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Source Portland Cement

A:

based on the attached graph, the production estimate of portland cement in 1975 is 492×10^6 bbb/yr

$$P_{75} = 492 \times 10^6 \text{ bbl/yr}$$

Ref 216 pg 130 1 bbl = 376 lb cement

Using K = .9 we may calculate the production capacity in 1975

$$A = \frac{492 \times 10^6 \frac{\text{bbl}}{\text{yr}} \times 376 \frac{\text{lb}}{\text{bbl}} \times \frac{\text{TON}}{2000 \text{ lb}}}{.90} \cong 103 \times 10^6 \frac{\text{TON}}{\text{Yr}}$$

$$\therefore \boxed{A = 103 \times 10^6 \frac{\text{TON}}{\text{Yr}} \text{ cement produced}}$$

3 of 4

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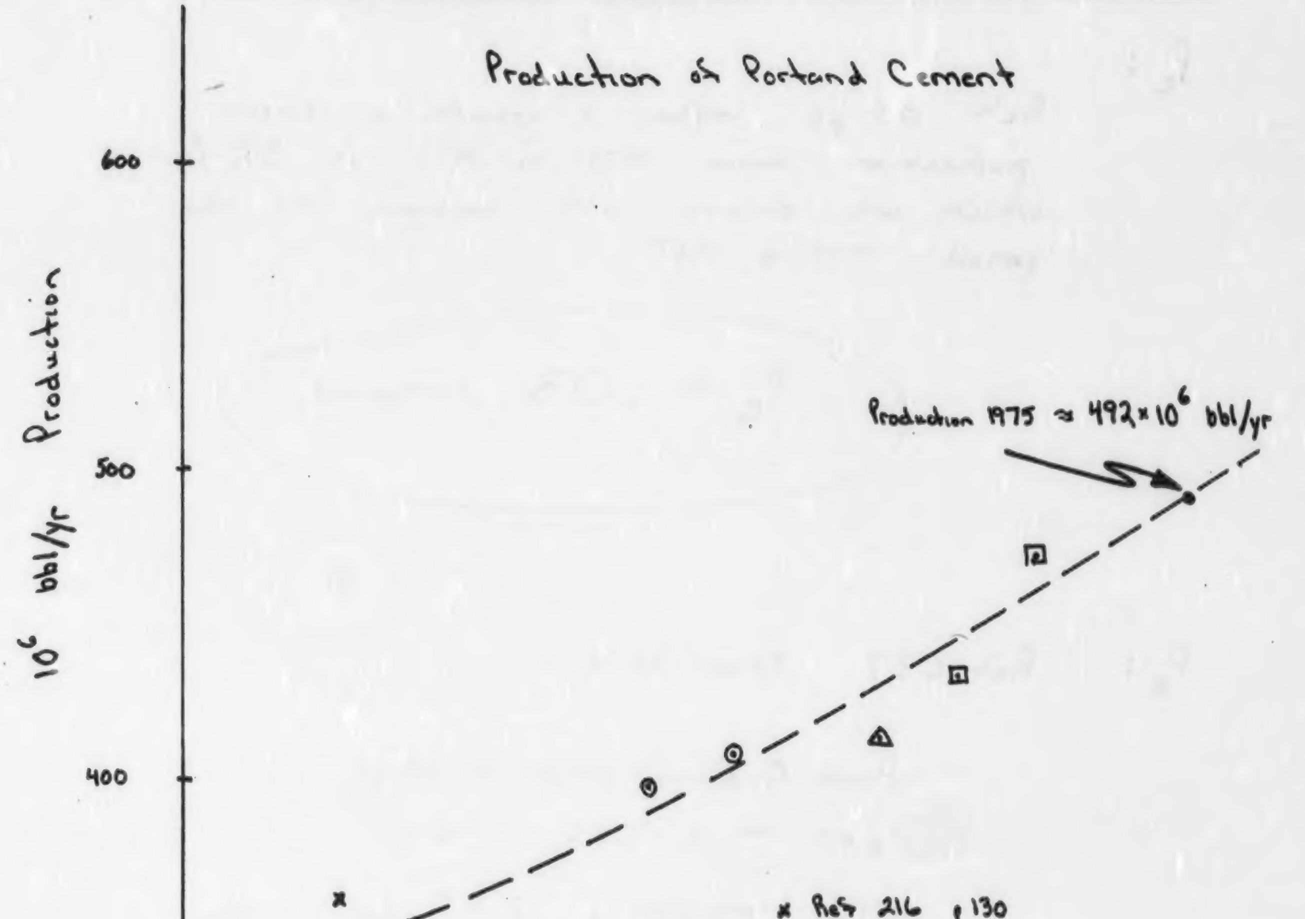
Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement



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Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 12-5-74

Source Portland Cement

P_C :

Ref 125 p6 implies a growth in cement production from 1971 to 1975 of 3% /yr which we assume will continue for the period 1975 to 1985

$$\boxed{P_C = .03 \text{ compound}}$$

P_B : Ref 037 Class 32.2

Asset Guideline period = 20 yrs

P_B est → 2 × IRS = 40 yrs

$$\frac{100\% \text{ depreciation}}{40 \text{ yrs}} = 2.5\% / \text{yr} \quad \text{simple}$$

$$\boxed{P_B = .025 \text{ simple}}$$

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Computation Sheet For Emission Factors

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Source Portland Cement

Ref 125 pg 102

in 1973 58% of US capacity is wet process cement plant
42% " " " " dry " " "

This same source indicates a condition in this industry of moving toward increased dry process production due to lower fuel consumption. The dry process is limited to a low moisture feed which may not always be available.

Note!! We make the assumption that 50% of the capacity will still be wet process during the period 1975 - 1985 so that emission factors developed for this industry will be the average from the two different process.

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

Particulates

E_u : Ref. 075 Table 8.6-1

Factors assumed (believed) to be in terms of lb / TON cement product.

	lb / TON		Avg lb/TON
	Wet Process	Dry Process	
Kiln	228	245	237
Cooler, dryer grinder	32	96	64

$$E = 237 + 64 \cong 301 \text{ lb/TON cement}$$

$$\therefore \boxed{E_u = 301 \text{ lb/TON cement}}$$

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Computation Sheet For Emission Factors

Calculations Done By W Marrone Date 12-5-74

Source Portland Cement

Particulates cont'd

E_N : Ref 017 p14 & 15 describe tests performed on various wet and dry process portland cement plants. [Tests presented in Ref 058 Table 4 & 5]

It was noticed that for the dry-process plant the highest efficiency attained (99.8%) was with a cyclone and baghouse system.

For the wet process the efficiency attained was 99.9% using a baghouse

It is recognized the cyclones and electrostatic precipitators are more often used in wet process plants, however we assume the use of baghouses.

$$\text{Eff} = \frac{99.9 + 99.8}{2} = 99.85\%$$

$$\therefore E_N = .0015 \times E_u = .0015 \times 301 = .45 \ \frac{\text{lb}}{\text{TON}}$$

$$\therefore E_N = .45 \ \text{lb/TON cement}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

Particulate cont'd

Ref 273 pg 24880 promulgated standard is equivalent to proposed.

E_s :

Ref 147 pg 27-28 gives proposed standards for new portland cement plants

$.3\ \text{lb}/_{\text{TON dry Feed}}$ from kiln

$.1\ \text{lb}/_{\text{TON dry feed}}$ from clinker cooler

$.4\ \text{lb}/_{\text{TON dry feed}}$

from Ref 216 p 130 . 600 lb feed → 1 bbl cement (376 lb)

or $\dfrac{600\ \text{lb feed}}{376\ \text{lb cement}} \approx 1.6$ feed to product ratio

therefore

$$E_{prop} = .4 \frac{\text{lb}}{\text{TON Feed}} \times \frac{1.6\ \text{TON Feed}}{\text{TON cement}} = .64 \frac{\text{lb}}{\text{TON cement}}$$

The emission regulations will be determined for new and existing plants. In any state the allowable level for new plants will not be permitted to be greater than $.64 \frac{\text{lb}}{\text{TON cement}}$ (.4 lb/TON Feed)

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Computation Sheet For Emission Factors

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Source Portland Cement

Particulate cont'd

E_S :

Ref 215 1972 169 cement plants

461 kilns

85.4×10^6 TONS/yr capacity

then

$$\frac{[illegible]}{\text{plant}} = \frac{85.4 \times 10^6 \frac{\text{TON}}{\text{yr}} \times 5.32 \frac{\text{bbl}}{\text{TON}}}{169 \text{ plant}} \cong 2.69 \times 10^6 \text{ Bbl/yr per plant}$$

$$\frac{\text{BBL/yr}}{\text{Kiln}} \quad \frac{85.4 \times 10^6 \frac{\text{TN}}{\text{yr}} \times 5.32 \frac{\text{bbl}}{\text{TON}}}{461 \text{ kiln}} = .99 \times 10^6 \text{ BBL/yr per kiln}$$

Since regulation would apply individually to each kiln we use the process production rate for a kiln

$\approx 1 \times 10^6$ bbl/yr

assuming 8400 hr/yr, 5.32 bbl/TON cement, and a feed to product ratio of 1.6 we may estimate the average process weight rate.

$$\text{P.W.R.} = 1.0 \times 10^6 \frac{\text{bbl}}{\text{yr}} \times \frac{\text{yr}}{8400 \text{ hr}} \times \frac{\text{TON cement}}{5.32 \text{ bbl}} \times \frac{1.6 \text{ TON feed}}{\text{TON cement}} \times \frac{2000 \text{ lb}}{\text{TON}}$$

$$\text{P.W.R.} = 71{,}608 \text{ lb/hr input}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

Particulate cont'd

E_s: Ref 058 Appendix pg 33-47 gives the yearly cement production capacities by state for the year 1966

We assume this breakdown representative and applicable to the period 1975-1985

The following table (pg 7 & 8) gives the fractional capacity in each state (A_i) and the applicable Emission limitation for now and existing portland cement plants. (Process weight rate 78,608 lb/hr feed)

Portland Cement

Allowable Particulate Emissions

	A_i	lb/ton cement Existing	New
Alabama	.019		
Alaska			
Arizona	.011		
Arkansas	.009		
Colorado	.010		
California	.124		
Conn.			
Delaware			
D.C.			
Florida	.031	1.34	.64
Georgia	.010		
Hawaii	.005		
Idaho	.002		
Illinois	.039		
Indiana	.043	4.00	.64
Iowa	.035	.90	.64
Kansas	.027		
Kentucky	.008		
Louisiana	.013		
Maine	.004		
Maryland	.016		
Mass.			
Michigan	.083		
Minn.	.004		
Miss.	.007		
Missouri	.041		
Montana	.006		
Nebraska	.010		
Nevada	.006		
N. Hampshire			
N. Jersey			
N. Mexico	.005		
New York	.078	1.82	.64
N. Carolina	.007	1.74	.64
N. Dakota			
Ohio	.040		

Portland Cement

	Ai	lb/ton cement Existing	New
klahoma	.018		
regon	.008		
enn.	.100	1.25	.64
R.I.			
Carolina	.012	1.41	.64
. Dakota	.007		
nnessee	.020		.64
Texas	.092		
Utah	.006		
ermont			
irginia	.015	1.85	.64
ashington	.015		
. Virginia	.008		
isconsin	.007		.64
yoming	.002		
	Σ 1.003		

rounding error
OK

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 4-25-75

Source Portland Cement

Particulate contd

E_s: For those states which have existing regulations for cement plants an E_s' is developed from $\Sigma E_{si} \times A_i$. For those states with no regulation E_{si}'' is obtained from the generalized process weight rate table and $E_s = \Sigma E_{si} \times A_i$ $\quad$ ∴ $E_s = E_s' + E_s''$

Since no state has a regulation for new plants which is more stringent than the proposed emission standard then we may conclude that $E_s\,(\text{new}) = E_s\,(\text{proposed})$

$$\boxed{E_s\,(\text{new}) = .64 \text{ lb/TON cement}}$$

For existing plants:

8 states have regulations that apply,

$$E_s' = .031\,(1.34) + .043\,(4.0) + .035\,(.90) + .078\,(1.82) + .007\,(1.74) + .10\,(1.25) + .012\,(1.41) + .015\,(1.85)$$

$$E_s' = .042 + .172 + .032 + .142 + .012 + .125 + .017 + .028$$

$$E_s' = .57 \text{ lb/TON cement}$$

For the remaining states $\Sigma A_i = 1 - .321 = .679$

$PWR = 71{,}608$ lb/hr feed

with Prod/Feed = $1/1.6$

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 4-25-75

Source Portland Cement

Particulate cont'd

E_s: Allowable emission from PWR table using 71,608 lb/hr input

$$E_A'' = 38\ \text{lb/hr}$$

$$E_A = \frac{38\ \text{lb/hr}}{71{,}608\ \text{lb}/\text{hr}_{\text{feed}}} \; \frac{\frac{1.6\ \text{lb feed}}{\text{lb cement}}}{\times\ \frac{\text{TON}}{2000\ \text{lb}}} = 1.698\ \text{lb}/\text{TON cement}$$

$$E_s'' = E_A \times A_i = 1.698 \times .679 = 1.15$$

$$E_s = E_s' + E_s'' = .57 + 1.15 = 1.72\ \text{lb}/\text{TON cement}$$

$$\boxed{E_s\ (\text{existing}) = 1.72\ \text{lb}/\text{TON cement}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SO_x

Ref 215 p 275 (1974 Edition)

In 1972 the following fuel usages were reported for this industry.

7,339,000 Tons coal
12,231,000 bbl oil (assume residual)
223,350,522,000 ft^3 gas

Using heating values from Ref 022 Table 4-1 pg 4-2

Gas: 1040 BTU/ft^3

Residual Oil: $.6384 \times 10^{10} \frac{BTU}{10^3 \, BBL}$ or $6.384 \times 10^6 \frac{BTU}{BBL}$

Coal: $2.62 \times 10^{10} \frac{BTU}{10^3 \, TONS}$ or $26.2 \times 10^6 \frac{BTU}{TON}$

We then calculate the BTU supplied by each fuel

$$Gas = 1040 \frac{BTU}{ft^3} \times 223.350522 \times 10^6 \, ft^3 \cong 23.23 \times 10^{10} \, BTU$$

$$Res\ Oil = 6.384 \times 10^6 \frac{BTU}{BBL} \times 12.231 \times 10^6 \, BBL = 7808 \times 10^{10} \, BTU$$

$$Coal = 26.2 \times 10^6 \frac{BTU}{TON} \times 7.339 \times 10^6 \, TONS = 19,228 \times 10^{10} \, BTU$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SO_x/ cont'd

The supply at heating value by fuel is

71.06% from coal
28.86% from oil
.08% from gas

Ref 022 %S in coal = 2%
p 4-4
Table 4-2 %S in residual oil = 1.5%

Ref 075 Table 8.6-1

Mineral Source	10.2 lb/TON		
Gas Comb	neg		
Oil Comb	4.2 S	or	6.3 lb/TON
Coal Comb	6.8 S		13.6 lb/TON

An emission factor from the fuel is calculated based on these figures and the weight factor for each fuel.

$$E_{fuel} = (0 \times .0008) + (6.3 \times .2886) + (13.6 \times .7106)$$
$$= 0 + 1.818 + 9.664$$
$$E_{fuel} \cong 11.5 \text{ lb/TON}$$

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Computation Sheet For Emission Factors
Calculations Done By W. Marrone Date 12-5-74
Source Portland Cement

SO_x/ cont'd

E_u:

$$E_u = E_{\text{mineral source}} + E_{\text{fuel}}$$

$$E_u = 10.2 + 11.5 = 21.7 \text{ lb/TON cement}$$

This factor is uncontrolled however, it does take into account the sulfur oxide reaction with the alkaline dusts in the kiln.

$$\therefore E_u = 21.7 \text{ lb/TON cement}$$

E_N:

Referring to Ref 201 pg 102 we see fuel requirements for six kiln systems. The long kilns are typical of present plants. The average value in the range for each system was obtained and then the average of all long kiln system was calculated

$$\text{Avg} = 6 \times 10^6 \frac{\text{BTU}}{\text{TON clinker}}$$

For the short kiln systems (using average values in range)

$$\text{Avg} = 3.68 \times 10^6 \frac{\text{BTU}}{\text{TON clinker}}$$

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Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SO_x / cont'd

E_N: We see that this may realize a heat saving of

$$\frac{6 - 3.68}{6} \times 100 = 38.6\%$$

We assume that at least a 35% savings in heat requirements can be achieved for new plants

Ref 075 Table 8.6-1 Note ⓐ 50% additional SO_2 reduction when baghouse used for particulate control due to further alkaline reactions.

$$E_N = .5\left(E_{mineral} + .65\left(E_{Fuel}\right)\right)$$

$$E_N = .5\left(10.2 + .65\left(11.5\right)\right)$$

$$E_N = 8.84 \text{ lb/TON cement}$$

$$\boxed{E_N = 8.84 \text{ lb/TON cement}}$$

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Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SOx / cont'd

E_s: Using the average heat requirement determined above 6×10^6 BTU/TON clinker

Ref 058 pg 19 suggests that 5% of cement is Gypsum implying that it is 95% clinker.

$$\text{Heat Req} = 6 \times 10^6 \frac{\text{BTU}}{\text{TON clinker}} \times .95 \frac{\text{TON clinker}}{\text{TON cement}}$$

$$= 5.7 \times 10^6 \text{ BTU/TON cement}$$

The typical kiln size, as calculated under E_s for particulates

$$\approx 1.0 \times 10^6 \frac{\text{BBL}}{\text{yr}} \times \frac{\text{yr}}{8400 \text{ hr}} \times \frac{\text{TON}}{5.32 \text{ BBL}} = 22.37 \frac{\text{TON cement}}{\text{HR}}$$

$$\frac{\text{BTU}}{\text{HR}} = 22.37 \frac{\text{TON cement}}{\text{hr}} \times 5.7 \times 10^6 \frac{\text{BTU}}{\text{TON cement}}$$

$$\text{Average } \frac{\text{BTU}}{\text{hr}} = 127.5 \times 10^6 \frac{\text{BTU}}{\text{hr}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SOx / cont'd

E_s : For those states with applicable regulations for SO_x we calculate a value of E_s (existing) and (new) weighted according to capacity occurrence in each state.

$$E_s'(\text{existing}) = \sum E_{s_i}^{(\text{existing})} \times A_i$$

$$E_s'(\text{new}) = \sum E_{s_i}^{(\text{new})} \times A_i$$

For states with no regulations then the value of E_s is determined simply by

$$E_s''(\text{new}) = \sum E_u^{\prime\,\text{Fuel}} \times A_i = E_u \times \sum A_i$$

$$E_s''(\text{existing}) = \sum E_u^{\prime\,\text{Fuel}} \times A_i = E_u \times \sum A_i$$

The total allowable" state's emission level for new and existing "fuel burning sources" is then;

$$E_s(\text{fuel}) = E_s' + E_s''$$

As noted above under E_u calculation a major portion of the SO_x emission is attributable to the mineral and therefore does not come under regulation

$$E_s(\text{actual}) = E_s(\text{mineral}) + E_s(\text{fuel})$$

where $E_s(\text{mineral}) = E_u(\text{mineral})$

Portland Cement

SO_x Limitation

basis : 127.5×10^6 BTU/HR

	Existing	New
	lb $SO_2/10^6$ BTU	
Alabama		1.2
Alaska		
Arizona	*	*
Arkansas	*	*
Colorado	.3	.3
California		
Conn.		
Delaware		
D.C.		
Florida		
Georgia		
Hawaii	3.05	3.05
Idaho		
Illinois	1.40	1.40
Indiana	1.20	1.20
Iowa		
Kansas		
Kentucky		2.0
Louisiana		
Maine	3.05	3.05
Maryland	1.5	1.5
Mass.		
Michigan		
Minn.		
Miss.	4.8	2.4
Missouri	2.3	2.3
Montana	1.0	1.0
Nebraska		
Nevada		
N. Hampshire		
N. Jersey		
N. Mexico		
New York		
N. Carolina	2.3	1.6
N. Dakota		
Ohio	2.9	1.0

	Existing	New
	lb SO_2/	10^6 BTU
klahoma		1.75
regon		1.5
Penn.		
R.I.		
. Carolina	2.7	2.7
. Dakota	3.0	3.0
ennessee	**	**
Texas	*	*
Utah	1.9	1.9
Vermont		
Virginia	2.6	2.6
ashington	**	**
. Virginia		
isconsin		
yoming		

* specifies ground level conc not to be exceeded (use $E_x = E_n$)

** specifies ppm limitation (not included in calculation)

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SOx / cont'd

E_s:

Existing Sources $E_s' = \sum E_i \times A_i$ \& $E_s'' = \overset{Fuel}{E_u'} \cdot \sum A_i$

$$E_s' = .01(.3) + .005(3.05) + .039(1.4) + .043(1.2) + .004(3.05) + .016(1.5) + .007(4.8) + .041(2.3) + .006(1.0) + .007(2.3) + .040(2.9) + .012(2.7) + .007(3.0) + .006(1.9) + .015(2.6)$$

$$E_s' = .5305 \ \frac{lb\ SO_2}{10^6\ BTU}$$

and with $5.7 \times \frac{10^6\ BTU}{TON\ cement}$

$$E_s' = .5305 \ \frac{lb\ SO_2}{10^6\ BTU} \times 5.7 \ \frac{\times 10^6\ BTU}{TON\ cement} = 3.02 \ \frac{lb\ SO_2}{TON\ cement}$$

now;

$$E_s'' = \overset{Fuel}{E_u} \times \sum A_i = 11.5 \ \frac{lb}{TON\ cement} \times .707 = 8.13 \ \frac{lb}{TON\ cement}$$

$.035 \times E_{Avg}$ for stacks not included in calc

$$\overset{E_s'}{3.02} + \overset{E_s''}{8.13} + \overset{Avg}{.035 E_A} = E_{Avg}$$

$$11.15 = .965 E_A \implies E_A = 11.55 \ \frac{lb}{TON}$$

$$E_s(fuel) = E_A = 11.55 \ lb/TON\ cement$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SOx/ cont'd

E_s:

$$E_s\,(\text{existing}) = E_s\,(\text{fuel}) + E_u\,(\text{mineral})$$

$$= 11.55 + 10.2$$

$\therefore$

$$E_s\,(\text{existing}) = 21.75 \approx E_u$$

then $\boxed{E_s\,(\text{existing}) = 21.7\ \text{lb/TON cement}}$

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Source Portland Cement

SO_x / cont'd

E_s: New Sources $E_s' = \Sigma E_{s_i} \times A_i$ & $E_s'' = E_u^{Fuel} \times \Sigma A_i$

$$E_s' = .019(1.2) + .01(.3) + .005(3.05) + .039(1.4) + .043(1.2) + .008(2) + .004(3.05) + .016(1.5) + .007(2.4) + .041(2.3) + .006(1.0) + .007(1.6) + .04(1.0) + .018(1.75) + .008(1.5) + .012(2.7) + .007(3.0) + .006(1.9) + .015(2.6)$$

$$E_s' = .5151 \frac{\text{lb } SO_2}{10^6 \text{ BTU}} \times 5.7 \times \frac{10^6 \text{ BTU}}{\text{TON cement}} = 2.94 \frac{\text{lb}}{\text{TON cement}}$$

and

$$E_s'' = E_{u_{Fuel}} \times \Sigma A_i = 11.5 \frac{\text{lb}}{\text{TON cement}} \times .654 = 7.52 \text{ lb/TON cement}$$

$.035 \times E_{Avg}$ for states not included in calc

$$E_s' + E_s'' + E_{Avg}(.035) = E_{Avg}$$

$$2.94 + 7.52 + .035 E_{Avg} = E_{Avg}$$

$$10.46 = .965 E_{Avg} \qquad E_{Avg} \approx 10.84 \frac{\text{lb}}{\text{TON}}$$

$$E_s(\text{fuel}) = E_{Avg} = 10.84 \frac{\text{lb}}{\text{TON cement}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-5-74

Source Portland Cement

SO_x/ cont'd

E_S: E_s(new) = E_s(fuel) + E_u(mineral)

= 10.84 + 10.2

E_s new = 21.04 ≈ 21.0

∴ E_s(new) = 21.0 lb/TON cement

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74

Source Portland Cement

NO_x

E_u: Ref 075 Table 8.6-1

Emission factor for uncontrolled wet process and dry process kiln is 2.6 lb/TON cement

$$\therefore \boxed{E_u = 2.6 \ \text{lb}/\text{TON cement}}$$

E_N: Ref to pg 14 of emission calc for SO_x in which a 35% savings in heat requirements was stated as achieveable at new cement plants. This savings in BTU/TON cement would imply a direct and proportional decrease in lb NO_x/TON cement

$$E_N = (1 - .35) \times 2.6 \ \frac{\text{lb}}{\text{TON}}$$

$$\therefore \boxed{E_N = 1.69 \ \text{lb}/\text{TON cement}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 12-6-74

Source Portland Cement

NO_x/E_s:

For NO_x emissions we will use the synthesized allowable emission rate developed by T. Hopper under "Boilers"

$.22 \text{ lb}/10^6 \text{ BTU}$ gas

$.30 \text{ lb}/10^6 \text{ BTU}$ oil

$.73 \text{ lb}/10^6 \text{ BTU}$ coal

using the fuel breakdown 71.06% coal, 28.86% oil, .08% gas we may calculate

$$E_{allow} = .7106(.73) + .2886(.30) + .0008(.22)$$

$$E_{Allow} = .51874 + .08658 + .00018$$

$$E_{Allow} = .6055 \text{ lb}/10^6 \text{ BTU}$$

and with the heat requirement of $5.7 \times 10^6 \frac{\text{BTU}}{\text{TON cement}}$

$$E_s = .6055 \text{ lb}/10^6 \text{BTU} \times 5.7 \times \frac{10^6 \text{BTU}}{\text{TON cement}}$$

$$E_s = 3.45 \text{ lb}/\text{TON cement}$$

since this value is greater than E_u E_s assumed equal to E_u

$$\therefore E_s = 2.6 \text{ lb}/\text{TON cement}$$

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Computation Sheet For Emission Factors

Calculations Done By D. Marrone Date 12-6-74

Source Portland Cement

Summary of Emission Factors

lb/TON cement

Pollutant	E_u	E_N	E_s (existing)	E_s (new)	
Particulate	301	.45	1.72	.64	
SO_x	21.7	8.84	21.7	21.0	
NO_x	2.6	1.69	2.6	2.6	

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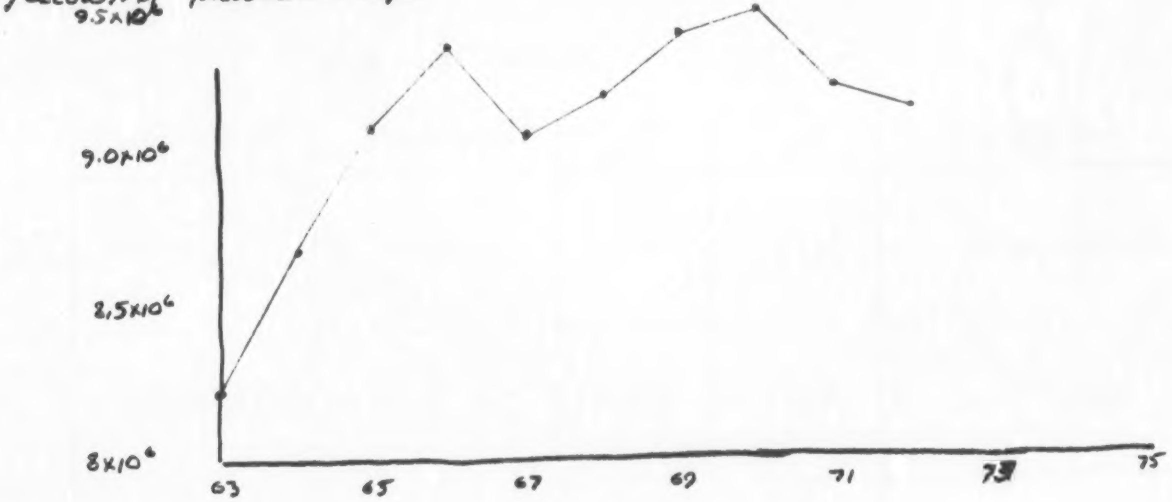
Computation Sheet For Industrial Factors

Calculations Done By Hooper Date 12/2/74

Source Sand & Gravel Processing

Ref (215) p 1103 (M74) & '61, '63, '65, '67, '69, '71 yield the following production info



Growth during the period 1963 to 1970 was based on the extensive use of sand & gravel for the interstate highway construction network. This effort has been gearing down in the past several years to the point where production may continue to decrease. However, for the purposes of this study, we will assume

$$\boxed{P_c = 0.0}$$

1972 Production = 913,375,000 tons

No specific reference could be located with respect to fractional utilization. From ref (144) p 48, K for "stone, clay & glass" = 80%. Presently, we will use this value for K.

$$\boxed{K = 0.80}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 12/2/74

Source Sand & Gravel

$$A = \frac{913.375 \times 10^6}{0.8} = 1142 \times 10^6$$

$$\boxed{A = 1142 \times 10^6 \text{ tons}}$$

P_B:

Ref ㊲ p30, states an allowable depreciation of 10 yrs for equipment used in the mining of "sand, gravel, stone & clay"

Assuming twice the IRS allowable,

$$P_B = \frac{1}{2(10)} = 0.05$$

$$\boxed{P_B = 0.05}$$

simple

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Computation Sheet For Emission Factors

Calculations Done By Hoare Date 12/2/74

Source SAND & GRAVEL

REF (75) p 8.19-1

$$\boxed{E_U = 0.1 \ \#/\text{ton}}$$

Generally, collection devices ARE NOT USED (REF ㊼ p 219)

However, using best available technology, a baghouse could be employED (Ref ㊻ p 342). This Ref states An $\eta \approx 100\%$. We will assume for the purpose of conservatism, 95% since the large volume of mat'l handled would cause eventual plugging & the operation would by-pass the baghouse during its cleanout

THIS ASSUMPTION IS BORN OUT IN REF ㊼ p 295 TAB 8-1 WHICH STATES 94% < η < 96% FOR SAND & GRAVEL PROCESSING CONTROL EQUIP'T

$$E_N = (1 - .95)(.1) = 0.005$$

$$\boxed{E_N = 0.005}$$

From Ref (215) 1974 p 1103 ff., the following State breakdowns EXISTED IN 1972

Cal. — 117×10^6 tons
Mich. — $\sim 59 \times 10^6$
Ill. — $\sim 40 \times 10^6$
Wisc. — 36.4×10^6
Minn. — 36.7×10^6
Ohio — 43.5×10^6
Texas — 35.1×10^6

367.7×10^6

$$\frac{367.7}{913.4} = 40\%$$

The remaining 60% is distributed THROUGHOUT THE REMAINING STATES

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/3/74

Source Sand & Gravel

Ref (215) p 1103ff

# plants in 1972 = 5384

$$\text{TYP plant size} = \frac{(913.4 \times 10^6)}{(5384)\quad(8760)} = 19.37 \text{ TPH} = 38{,}733\ \#/\text{HR}$$

$19.37/.80 = 24.21$ TPH

$38{,}733/.80 = 48{,}416$ #PH

% breakdown

Cal — 12.8%
Mich — 6.5%
Ill — 4.4%
Wisc — 4.0%
Minn - 4.0%
Ohio - 4.8%
Tex - 3.8%
Others - 59.7%

From Refs (84), (148) & (156) incl. gen'l process weight curve

Allowable emissions (#/HR) are . . . .

Cal — 27.0
Mich - 29.5
Ill — 12.1
Wisc - 22.4

Minn - 29.5
Ohio - 29.5
Tex — 57.0
Others - 28.1

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/3/74

Source Sand & Gravel

$$E_s = f\Big[(27.0)(.128) + (29.5)(.065) + (12.1)(.044) + (22.4)(.04) + (29.5)(.04) + (29.5)(.048) + (57.0)(.038) + (28.1)(.597)\Big]$$

$$= 3.456 + 1.918 + .532 + .896 + 1.18 + 1.416 + 2.166 + 16.776$$

$$= 28.34 \text{ PPH}$$

$$E_s = \frac{28.34}{24.21} = 1.17 \text{ \#/ton}$$

The uncontrolled emission rate is less than $E_{s\,\text{calculated}}$

$$\therefore \quad E_s = E_u = 0.1 \text{ \#/ton}$$

$$\boxed{E_s = 0.1 \text{ \#/ton}}$$

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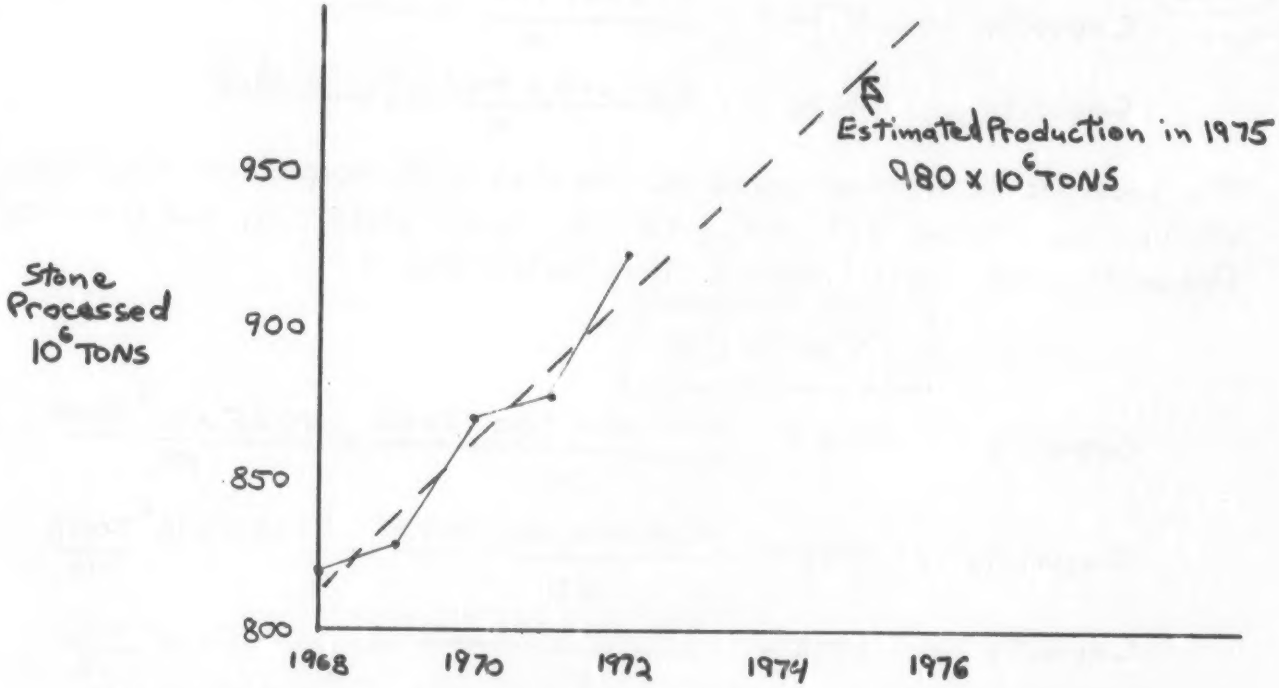
Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/27/74.

Source Stone Quarrying and Processing

Ref 215 yields the following production information:



Estimated Production in 1975 980×10^6 TONS

These data points seem to indicate a simple growth rate for the Stone Quarry and Processing Industry. Future predictions of this industry are difficult because of the slow down of interstate highway construction in recent years. In order to minimize potential error we assume a simple growth rate for this reason also.

$$P_c = \frac{\text{Capacity in 1972} - \text{Capacity in 1968}}{(1972-1968)\ \text{Capacity in 1975}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/27/74

Source Stone Quarrying and Processing

$$\text{Capacity in 1968} = \frac{\text{Production in 1968}}{K}$$

$$\text{Capacity in 1972} = \frac{\text{Production in 1972}}{K}$$

$$\text{Capacity in 1975} = \frac{\text{Estimated Production in 1972}}{K}$$

No specific reference could be located with respect to fractional utilization. From Ref. 144, p.48, K for "stone, clay, and glass" = 80% Presently, we will assume this value for K

$$\boxed{K = 0.80}$$

$$\text{Capacity in 1968} = \frac{820{,}000{,}000 \text{ TONS}}{.80} = \frac{1025 \times 10^6 \text{ TONS}}{\text{YR}}$$

$$\text{Capacity in 1972} = \frac{924{,}000{,}000 \text{ TONS}}{.80} = 1155 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$\text{Capacity in 1975} = \frac{980{,}000{,}000 \text{ TONS}}{.80} = 1225 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$P_c = \frac{1155 \times 10^6 \frac{\text{TONS}}{\text{YR}} - 1025 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{(4)\left(980 \times 10^6 \frac{\text{TONS}}{\text{YR}}\right)} = \frac{130 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{(4)\left(980 \times 10^6 \frac{\text{TONS}}{\text{YR}}\right)} = .033$$

$$\boxed{P_c = \underset{\text{simple}}{.033}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

Ref 37, p. 30 states an allowable depreciation of 10 yrs for equipment used in the mining of "sand, gravel, stone & clay"

Assuming twice the IRS allowable,

$$P_B = \frac{1}{(2)(10)} = 0.05$$

$$P_B = 0.05 \text{ simple}$$

From the graph shown previously estimated production in 1975 is 980×10^6 TONS.

$$A = \frac{\text{Production in 1975}}{K} = \frac{980 \times 10^6 \text{ TONS}}{.8} = 1225 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$\boxed{A = 1225 \times 10^6 \frac{\text{TONS}}{\text{YR}}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying & Processing

Ref 075, Table 8.20-1, p. 8.20-1 gives the following information for particulate emission factors for rock handling processes.

Type of Process	Uncontrolled Total lbs/TON
Primary Crushing	0.5
Secondary Crushing & Screening	1.5
Tertiary crushing & screening	6
Recrushing & screening	5
Fines Mill	6
Misc. Operations (Screening, conveying and handling)	2
Storage Pile Losses	10

Ref. 050, p. 9 makes the following assumptions to arrive at a uncontrolled emission factor for the stone quarrying & processing industry.

1. Growth of production at 1.5% over 1971 base year.
2. All production is primary and secondary crushed and screened.
3. 75% of production is tertiary crushed and screened.
4. 20% of production is recrushed and screened
5. Storage pile losses are ignored
6. Growth in number of quarries at 3% over 1971 base year.

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying & Processing

$$E_u = 0.5\,\frac{\text{lb}}{\text{Ton}} + 1.5\,\frac{\text{lb}}{\text{TON}} + (0.75)(6\,\frac{\text{lb}}{\text{Ton}}) + (0.2)(5\,\frac{\text{lb}}{\text{TON}}) + 6\,\frac{\text{lb}}{\text{TON}} + 2\,\frac{\text{lb}}{\text{TON}} = 15.5\,\frac{\text{lb}}{\text{TON}}$$

$$\boxed{\begin{array}{c} E_u = 15.5\,\frac{\text{lb}}{\text{TON}} \\ \text{rock processed} \end{array}}$$

Ref 075, p. 8.20-1 states that efficiencies of 99% can be expected for stone quarry & processing emissions by using a fabric filter.

$$E_N = \left(15.5\,\frac{\text{lb}}{\text{TON}}\right)(1.00 - .99) = \left(15.5\,\frac{\text{lb}}{\text{TON}}\right)(.01) = .155\,\frac{\text{lbs}}{\text{TON}}$$

$$\boxed{\begin{array}{c} E_N = .155\,\frac{\text{lbs}}{\text{TON}} \\ \text{rock processed} \end{array}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

Ref 050, p. 4 gives the following information regarding number of quarries and plant capacity in 1970.

Yearly Capacity (TONS/YR)	*Hourly Capacity (lbs/Hour)	% of Total # of quarries
Less than 24,999	Less than 24,999	36.4
25,000 to 49,999	25000 to 49,999	11.8
50,000 to 74,999	50000 to 74.999	7.7
75,000 to 99,999	75,000 to 99,999	5.9
100,000 to 199,999	100,000 to 199,999	13.5
200,000 to 299,999	200,000 to 299,999	6.1
300,000 to 399,999	300,000 to 399,999	4.9
400,000 to 499,999	400,000 to 499,999	3.5
500,000 to 599,999	500,000 to 599,999	2.2
600,000 to 699,999	600,000 to 699,999	1.6
700,000 to 799,999	700,000 to 799,999	1.3
800,000 to 899,000	800,000 to 899,999	1.1
900,000 and up	900,000 and up	4.0

* lbs/hr values were obtained by assuming that each plant operated 250 day/yr 8 hrs/day, ref 236, p. VII-59

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

From the general process weight curve obtained from ref 084 and ref 148 we obtain the following calculation for E_s.

$$E_s = (.364)(21\ \tfrac{lbs}{hr}) + (.118)(34\ \tfrac{lbs}{hr}) + (.077)(37.5\ \tfrac{lbs}{hr}) + (.059)(40\ \tfrac{lbs}{hr})$$

$$+ (.135)(47\ \tfrac{lbs}{hr}) + (.061)(51\ \tfrac{lbs}{hr}) + (.049)(56\ \tfrac{lbs}{hr}) + (.035)(59\ \tfrac{lbs}{hr})$$

$$+ (.022)(61\ \tfrac{lbs}{hr}) + (.016)(62\ \tfrac{lbs}{hr}) + (.013)(66\ \tfrac{lbs}{hr}) + (.011)(68\ \tfrac{lbs}{hr}) +$$

$$(.040)(70\ \tfrac{lbs}{hr})^{*} = \longrightarrow$$

* Ref 050, p.11.

$$[7.64 + 4.01 + 2.89 + 2.36 + 6.35 + 3.11 + 2.74 + 2.07$$

$$1.34 + 0.99 + 0.86 + 0.75 + 2.80] = 37.91\ \tfrac{lbs}{hr}.$$

$$E_s = \frac{\left(37.91\ \tfrac{lbs}{hr}\right)}{\left(\text{Avg. Plant Capacity}\ \tfrac{TON}{hr}\right)}$$

$$\text{Average Plant}\ \tfrac{TON}{YR} = (25{,}000\ \tfrac{TONS}{YR})(.364) + (50{,}000)(.118) + (75000)(.077) +$$

$$(100{,}000)(.059) + (200{,}000)(.135) + (300{,}000)(.061) + (400{,}000)(.049) +$$

$$(500{,}000)(.035) + (600{,}000)(.022) + (700{,}000)(.016) + (800{,}000)(.013) +$$

$$(900{,}000)(.011) + (1{,}000{,}000)(.04)^{*} =$$

* Ref 050, p.11

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/30/74

Source Stone Quarrying and Processing

$$9100 + 5900 + 5775 + 5900 + 27{,}000 + 18{,}300 + 19{,}600 + 17{,}500 + 13200 + 11{,}200 + 10{,}400 + 9900 + 40{,}000 = 193{,}775 \frac{\text{TONS}}{\text{YR}}$$

We make the assumption that an average plant operates 250 days/yr, 8 $\frac{\text{hrs}}{\text{day}}$.

$$\text{Average Plants Capacity} \frac{\text{TON}}{\text{hr}} = \frac{193{,}775 \frac{\text{TONS}}{\text{YR}}}{\left(250 \frac{\text{days}}{\text{yr}}\right)\left(8 \frac{\text{hrs}}{\text{day}}\right)} = 96.9 \frac{\text{TONS}}{\text{hr.}}$$

This value of 96.9 $\frac{\text{TONS}}{\text{hr}}$ is substantiated by ref. 236, p. VII - 59 which states that typical plant capacities average 100 TON/HR.

$$E_s = \frac{37.91 \frac{\text{lbs}}{\text{hr.}}}{100 \frac{\text{TONS}}{\text{hr}}} = .379 \frac{\text{lbs}}{\text{TON}}$$

$$\boxed{E_s = .379 \frac{\text{lbs}}{\text{TON Rock Processed}}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 6/3/75

Source Mining & Milling of Lead

Ref ㉗⑧ p 17

1970 Production = 571,767 tons Lead/yr

Using information from our study regarding primary lead smelters (See "Industrial Factors – Primary Lead")

$$\boxed{P_C = 0}$$

Our study indicated that 2 (of 4) producers of 1° Pb operated @ 85% of capacity & the remaining two operated @ 99%. We will assume that the mining & milling operations function @ the av'g of these

$$K = \frac{.85+.99}{2} = 0.92$$

$$\boxed{K = 0.92}$$

$$A = 0.572\times10^6 / .92 = 0.622\times10^6$$

$$\boxed{A = 0.622\times10^6 \text{ tons Pb/yr}}$$

Ref ㊲ p 30 Sec 10.0 Mining. The IRS depreciation guideline is 10 yrs. Assuming twice the average.

$$P_D = \frac{1}{2(10)} = 0.05 \qquad \boxed{P_D = 0.05} \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 6/5/75

Source Mining & Milling of Lead

Ref (278) p 16

$$\boxed{E_{U_{Pb}} = 0.2 \ \text{LB} / \text{TON of LEAD MINED}}$$

Ref (280) Data from p 4-33, 34 would indicate that 0.2 is the uncontrolled level

Ref (280) p 4-35 indicates that controls could consist of H_2O sprays; hooding, cyclones, wet scrubbers, & baghouses. Since this is a transfer of technology from rock crushing plants in gen'l, we will assume an average control efficiency of 50 %.

$$\boxed{E_{N_{Pb}} = 0.1 \ \text{LB} / \text{TON LEAD MINED} \neq E_{IIId}}$$

Ref (278) p 17 indicates 20 LB/day of lead

$$20.0 = .2 \, (\text{TPD lead}) \qquad \text{TPD lead} = 100$$

Assuming 16 hr/day op'n $\quad TPH = 100/16 = 6.25 \ TPH = 12{,}500 \ PPH$

From (278) p 14 Avg % Pb = 0.048

$$PWR = 12500/.048 = 260{,}417 \ PPH$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 6/5/75

Source Mining + Milling of Lead

Ref ㉗⑧ p.7

6 mines in Misso. & 1 in Idaho

From Ref (84) & (148) PWR curves for 260,000 pph rock

MO. = 53.5 LB/HR
Idaho = 53.5 LB/HR

@ 4.8% LEAD & assuming particulate control results in "de facto" lead control

$$Es_{pb} = \frac{(53.5)(.048)}{6.25} = 0.411 \text{ LB/TON Pb}$$

Since this is > EU, ES ≡ EU

$$\boxed{Es_{pb} = 0.2 \text{ LB/TON LEAD MINED}}$$

Particulate

For 4.8% Lead

$$Eu_p = .2/.048 = 4.17$$

$$\boxed{Eu_p = 4.17 \text{ LB/TON LEAD}}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 6/5/75

Source Mining & Milling of Lead

$$E_N = .5(4.17) = 2.09$$

$$\boxed{E_{Np} = 2.09 \ \text{LB}/\text{TON LEAD}}$$

$$E_{Sp} = E_{Up}$$

$$\boxed{E_{Sp} = 4.17 \ \text{LB}/\text{TON LEAD}}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/3/74

Source BRICK & RELATED Clay PRODUCTS

THIS category includes the grinding, screening, blending, forming, drying, curing & firing of clay pipe, pottery + some types of refractory brick. It does not include castable refractories.

REF (49) p 309 TAB 14-1

1968 PRODUCTION = 23.7×10^6 TONS

FROM REF ⑱ $P_c = 2.7\%$ simple

$\therefore \boxed{P_c = 0.027}$ simple

1975 PRODUCTION = $(23.7 \times 10^6)[1+.027]^7 = 28.56 \times 10^6$ TONS

No direct information could be found regarding fractional utilization, K. However, we can estimate it from that of similar industries.

REF (144) p 48 indicates a K for "stone, clay & glass" = 80% for the period 1965-1973. We will assume this value

$\boxed{K = 0.80}$

$$A = \frac{28.56 \times 10^6}{0.80} = 35.7 \times 10^6$$

$\boxed{A = 35.7 \times 10^6 \text{ TONS}}$

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Computation Sheet For Industrial Factors

Calculations Done By Hoffer Date 12/3/74

Source Brick & Clay Products

for "other stone & clay products"

From Ref ③⑦ p34, the IRS allowable depreciation is 15 yrs. Assuming twice the allowable,

$$P_B = \frac{1}{2(15)} = 0.033$$

$$\boxed{P_B = \underset{\text{simple}}{0.033}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay Products

PARTICULATES

REF (75) p 8.3-3 TAB 8.3-1

RAW MAT'L HANDLING = 96 #/TON
STORAGE = 34 #/TON

Curing & firing

REF (18) p 2-8 INDICATES

① "COAL, OIL & GAS ARE ALL USED TO HEAT THE KILN, HOWEVER, GAS IS BY FAR THE MOST COMMONLY USED FUEL."

② "PERIODIC KILNS ARE ALSO USED TO FIRE TILE, PIPE AND BRICK. BUT, THEY ARE NOT WIDELY USED ESPECIALLY IN MODERN PLANTS."

∴ We assume

① 75% GAS
20% OIL
5% COAL

② 75% TUNNEL KILNS
25% PERIODIC KILNS

These assumptions DO NOT APPEAR TO BE CRITICAL SINCE PARTICULATE EMISSIONS FROM HANDLING AVERAGE ~100 TIMES GREATER THAN PARTICULATE COMBUSTION EMISSIONS

FROM REF (75) p 8.3-3 TAB 8.3-1

TUNNEL KILNS		PERIODIC KILNS
GAS - .04	#/TON	GAS - .11
OIL - .6		OIL - .9
COAL - 1.0A		COAL - .5A

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay

$$E_{U_p} = (.75)\left[.04(.75) + (.6)(.2) + (1.0A)(.05)\right]$$

$$+$$

$$(.25)\left[(.11)(.75) + (.9)(.2) + (.5A)(.05)\right]$$

$$+$$

$$96.0 + 34.0$$

↑ Assumes storage ≡ Production

Assume ash content (A) = 8.1% Ref ㉒ p 4-4

$$E_{U_p} = .75(.03 + .12 + .41) + (.25)(.08 + .18 + .20) + 96 + 34$$

$$= .42 + .11 + 96 + 34 = 130.5 \text{ \#/ton}$$

$$\boxed{E_{U_p} = 130.5 \text{ \#/TON}}$$

Ref ⑱ p 5-2 TAB 5.1 INDICATES CONTROL = 99% for blending STORAGE & GRINDING USING fabric filters

$$\eta = \frac{313 - 3.1}{313} = 99\%$$

Ref ⑱ p 3-1 STATES $\eta = 97\%$ for combustion particulates employing A MEDIUM ENERGY SCRUBBER

So, $E_N = (130)(.01) + (.5)(.03) = 1.3 + .015 = 1.315$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay

$$\boxed{E_{N_p} = 1.32 \text{ \#/TON BRICK, ETC.}}$$

Since brick & clay products mfg takes place in nearly ALL STATES & THERE ARE 851 PLANTS doing so (Ref ⑱ P 1-2 TAB 1.1), we will use the general PWR curve.

$$\frac{23.7\times10^{6}\text{ TONS}}{(851)(8760)} = 3.179 \text{ TPH PRODUCTION = TYP PLANT SIZE}$$

$$\frac{3.179}{.8} = 3.974 \text{ TPH CAPACITY = TYP PLANT SIZE}$$

REF ⑱ p 2-3, 2-4 INDICATES A FEED/PRODUCT = $4890/4170 = 1.173$

$$PWR = 3.974(1.173) = 4.66 \text{ TPH} = 9323 \text{ \#/HR}$$

From the gen'l PWR curve,

Allowable = 11.0 #/HR

$$E_S = 11.0/3.97 = 2.77 \text{ \#/TON}$$

$$\boxed{E_{S_p} = 2.77 \text{ \#/TON PRODUCT}}$$

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Source Brick & Clay

It is conceivable that Es could be det'd separately for the combustion aspect of the emissions.

REF ⑱ p 2-8 STATES $(3-5)\times10^6$ BTU per ton of brick for tunnel kilns

$$\frac{.5\,\#/\text{ton brick}}{4\times10^6\ \text{BTU}/\text{ton brick}} = 0.125\ \#/10^6$$

which is less than the allowable for gas fuel alone

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/3/74

Source Brick & Clay

SOx

SOx emissions are from the combustion process in the kilns. Using the same assumptions as for particulates & the following factors from Ref (75) p8.3-3 Tab 8.3-1

Tunnel	Periodic
Gas – Neg	Gas – Neg
Oil – 4.0S	Oil – 5.9S
Coal – 7.2S	Coal – 12.0S

% Sulfur (S) oil = .265% Ref (97) p19 Tab 4.9 (Arith. Avg)

% Sulfur (S) coal = 2.00% Ref ㉒ p4-4 Tab 4-2

$$E_{U_{SO_2}} = (.75)\left[.75(0.0) + (.20)(4.0)(.265) + (.05)(7.2)(2.00)\right]$$

$$+$$

$$(.25)\left[(.75)(0.0) + (.20)(5.9)(.265) + (.05)(12.0)(2.00)\right]$$

$$= (.75)(.212 + .72) + (.25)(.313 + 1.2) = .699 + .378$$

$$= 1.077 \ \#/\text{ton}$$

$$\boxed{E_{U_{SO_2}} = 1.077 \ \#/\text{ton product}}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/3/74

Source BRICK & CLAY PRODUCTS

REF ⑱ p 3-1 STATES $R = 60\%$ for SO_2 using medium energy WET SCRUBBER

$$E_{N_{SO_2}} = (1-.60)(1.077) = 0.431$$

$$\boxed{E_{N_{SO_2}} = 0.431 \ \#/\text{TON}}$$

Previous calkulations regarding "Boilers" done by HOPPER for this project indicate allowable nationwide emission rate of 1.589 $\#/10^6$ for oil for units $< 250 \times 10^6$ BTU/HR

Again, using the value of 4×10^6 BTU/ton BRICK

$$E'_{U_{SO_2}} = \frac{1.077 \ \#/\text{TON}}{4 \times 10^6 \ \#/\text{TON}} = 0.269 \ \#/10^6 \text{ BTU}$$ which is less than the allowable.

$\therefore E_S = E_U = 1.077$

$$\boxed{E_{S_{SO_2}} = 1.077 \ \#/\text{TON PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hooper Date 12/3/74

Source Brick & Clay

CARBON MONOXIDE

Assuming the same breakdowns as with the other pollutants, & from Ref (75) p 8.3-3 TAB 8.3-1

TUNNEL		PERIODIC		
GAS —	.04	GAS —	.11	#/TON
OIL —	NEG	OIL —	NEG	
COAL —	1.9	COAL —	3.2	

$$E_{U_{CO}} = .75\left[(.75)(.04) + 0 + .05(1.9)\right] + .25\left[(.75)(.11) + 0 + .05(3.2)\right]$$

$$= .75(.03 + .095) + .25(.083 + .16) = .094 + .061$$

$$\boxed{E_{U_{CO}} = 0.155 \text{ \#/TON PRODUCT}}$$

Since no feasible controls (other than proper combustor maintenance) exist, we will set EN = 0.0 to determine the max hypothetical emissions impact to detn if control techology should be developed

$$\boxed{E_{N_{CO}} = 0.0}$$

Since there are no regulations re: CO, Es = Eu

$$\boxed{E_{S\,CO} = 0.155 \text{ \#/ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/3/74

Source Brick & Clay Products

Hydrocarbons

Assuming the same breakdowns as with the other pollutants & from REF ⑦⑤ p8.3-3 TAB 8.3-1

TUNNEL	PERIODIC	
GAS — .02	GAS — .04	
OIL — .1	OIL — .1	#/TON
COAL — .6	COAL — .9	

$$E_{U_{HC}} = .75\left[(.75)(.02) + (.2)(.1) + (.05)(.6)\right] + (.25)\left[.75(.04) + (.2)(.1) + .05(.9)\right]$$

$$= .75\left[.015 + .02 + .03\right] + (.25)\left[.03 + .02 + .045\right]$$

$$= .0488 + .0238 = .0726$$

$$\boxed{E_{U_{HC}} = .0726 \text{ \#/TON}}$$

Assume $E_N = 0.0$ for the same reasons as CO

$$\boxed{E_{N_{HC}} = 0.0}$$

Since there are no regs, $E_S = E_U$

$$\boxed{E_{S_{HC}} = 0.0726 \text{ \#/TON}}$$

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Source Brick & Clay

NOx

Assuming the same breakdowns as with the other pollutants & from Ref ⑦⑤ p 8.3-3 TAB 8.3-1

TUNNEL	PERIODIC
GAS - .15	GAS - .42
OIL - 1.1	OIL - 1.7
COAL - .9	COAL - 1.4

$$E_{U_{NO_x}} = .75\left[(.75)(.15) + (.2)(1.1) + (.05)(.9)\right] + .25\left[(.75)(.42) + (.20)(1.7) + (.05)(1.4)\right]$$

$$= .75(.113 + .22 + .045) + .25(.315 + .340 + .07)$$

$$= .2835 + .1813 = 0.465$$

$$\boxed{E_{U_{NO_x}} = 0.465 \ \#/\text{TON}}$$ — for residential heating

Ref (242) p 7-13, 7-16 indicate a reduction in NO_x of ~50% by 1985 we will use this value & include the results in the E_N = 0.0 etc category

$$E_N = (1-.5)(.465) = 0.233 \quad \boxed{E_N = 0.233 \ \text{LB}/\text{TON}}$$

Previous calculations regarding "Boilers" done by Hopper for this project indicate a nationwide allowable emission rate of

.22 - gas
.30 - oil
.73 - coal
} #/10⁶ BTU

Synthesizing,

$$(.75)(.22) + (.2)(.3) + .05(.73) = .165 + .06 + .037 = .262$$

Again, using the value of 4×10^6 BTU/ton brick

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Calculations Done By Hoare Date 12/4/74.

Source Brick & Clay Products

$\frac{.465}{4 \times 10^6} = 0.116 \ \#/10^6 \text{BTU}$ Since this is less than the allowable, we will set $E_S = E_U$

$$\boxed{E_{S_{NOx}} = 0.465 \ \#/\text{TON PRODUCT}}$$

Fluorides

From Ref (75) p 8.3-3 TAB 8.3-1

$$\boxed{E_{U_F} = 1.0 \ \#/\text{TON}}$$ (For both kiln types)

From Ref ⑱ $\eta = 70\%$ using a medium energy wet scrubber

$$E_N = 1.0(1-.7) = 0.3 \ \#/\text{TON}$$

$$\boxed{E_{N_F} = 0.3 \ \#/\text{TON PRODUCT}}$$

Ref (89) & ㊽ There are no regs applicable to F^- emissions from brick & clay mfg

$\therefore E_S = E_U$

$$\boxed{E_{S_{F^-}} = 1.0 \ \#/\text{TON}}$$

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Calculations Done By Hopper Date 12/4/74

Source Brick & Clay

$E_{111(d)}$

Since a wet scrubber can be retrofit to an existing installation, we will assume $E_{111d} \equiv E_N$

$$E_{111(d)_{F^-}} = 0.3 \ \#/\text{ton product}$$

SUMMARY

	E_U	E_N	E_S	$E_{111(d)}$
PART	130.5	1.32	2.77	—
NOx	.465	.233 ~~0.0~~	.465	—
SO_x	1.077	.431	1.077	—
HC	.0726	0.0	.0726	—
F^-	1.0	.30	1.0	.3
CO	.155	0.0	.155	—

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 4/25/75

Source Calcium Carbide

THIS is AN update of the 11/25/74 calculation sheet

Ref ⑨⑤ p 724.5020 A JAN '72

DATA INDICATE A decline in the production of calcium carbide. The following ¶ from p 724.5020C of Ref ⑨⑤ indicates why

The largest use for calcium carbide is for production of acetylene. Most Reppe chemicals and acetylenic alcohols are made from calcium carbide-derived acetylene. Some trichloroethylene and perchloroethylene are made from calcium carbide-derived acetylene; however, most trichloroethylene and perchloroethylene are now manufactured from ethylene or hydrocarbon-acetylene (e.g., acetylene manufactured by the partial oxidation of methane). At one time, all neoprene was manufactured from calcium carbide-derived acetylene, but now butadiene is the main raw material. Ethylene and hydrocarbon-acetylene have very nearly replaced all calcium carbide-derived acetylene in vinyl acetate manufacture, and have replaced calcium carbide-derived acetylene in vinyl chloride manufacture. Acrylic acid and esters manufacture is no longer based on calcium carbide-acetylene. Propylene has completely replaced calcium carbide-derived acetylene in acrylonitrile manufacture. One source believes that calcium carbide-derived acetylene may cease to be used for the manufacture of chemicals by 1973. (See the CEH ACETYLENE report for further information on chemical uses for acetylene.) The main non-chemical use for calcium carbide-derived acetylene is in welding.

Calcium carbide is used in metallurgy for desulfurizing and deoxidizing. In Canada, it is used to produce calcium cyanamide; calcium cyanamide is not produced in the United States, however. (See the CEH data sheet "Calcium Cyanamid – Imports" for further information.)

From p 724.5020 C

1966 CAPACITY = 1.195×10^6 TONS

1970 CAPACITY = $.963 \times 10^6$ TONS

$$P_c = \sqrt[4]{\frac{.963}{1.195}} - 1.0 = -5.3\%$$

$$\boxed{P_c = -0.053}$$

$$A = (.963 \times 10^6)(1 - .053)^5 = 0.733 \times 10^6$$

$$\boxed{A = 0.733 \times 10^6 \text{ TONS CALCIUM CARBIDE}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 4/28/75

Source Calcium Carbide

From Ref ㊲, p33, the IRS allowable depreciation is 11 yrs. Assuming an obsolescence rate of twice this,

$$\text{Obs. Rate} = \frac{1}{22} = 0.045$$

Since P_G is greater than this, we can assume that no obsolete facilities are being replaced. In fact, it is probable that existing plants would be shut down or the productivity decreased.

$$\boxed{P_B = 0}$$

Ref (95) p 724.5020 A

1970 Capacity = $.963 \times 10^6$ tons
1970 Production = $.780 \times 10^6$

$$\boxed{K = 0.81}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper, Date 1/28/75

Source Calcium Carbide

Since P_C is negative & $P_B = 0$, NSPS will apply only to emissions of designated pollutants from existing sources. Since there would appear to be no designated pollutant emissions from the mfg. of calcium carbide, we will not develop any emission factors @ this time.

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OBS CALCS

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOMER Date 11/25/74

Source CALCIUM CARBIDE

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REF ⑨⑤ p 724.5020A JAN '72

DATA INDICATE A DEFINITE DECLINE IN THE PRODUCTION OF CALCIUM CARBIDE. THE FOLLOWING ¶ from p 724.5020C OF REF ⑨⑤ INDICATES WHY

The largest use for calcium carbide is for production of acetylene. Most Reppe chemicals and acetylenic alcohols are made from calcium carbide-derived acetylene. Some trichloroethylene and perchloroethylene are made from calcium carbide-derived acetylene; however, most trichloroethylene and perchloroethylene are now manufactured from ethylene or hydrocarbon-acetylene (e.g., acetylene manufactured by the partial oxidation of methane). At one time, all neoprene was manufactured from calcium carbide-derived acetylene, but now butadiene is the main raw material. Ethylene and hydrocarbon-acetylene have very nearly replaced all calcium carbide-derived acetylene in vinyl acetate manufacture, and have replaced calcium carbide-derived acetylene in vinyl chloride manufacture. Acrylic acid and esters manufacture is no longer based on calcium carbide-acetylene. Propylene has completely replaced calcium carbide-derived acetylene in acrylonitrile manufacture. One source believes that calcium carbide-derived acetylene may cease to be used for the manufacture of chemicals by 1973. (See the CEH ACETYLENE report for further information on chemical uses for acetylene.) The main non-chemical use for calcium carbide-derived acetylene is in welding.

Calcium carbide is used in metallurgy for desulfurizing and deoxidizing. In Canada, it is used to produce calcium cyanamide; calcium cyanamide is not produced in the United States, however. (See the CEH data sheet "Calcium Cyanamid – Imports" for further information.)

$\therefore \boxed{P_C < 0}$ (-6.7%)

Because of this decline in production, there would appear to be no economic incentive to replace obsolete capacity.

$\therefore \boxed{P_B = 0}$

This industry does not appear to be applicable for NSPS

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/4/74

Source CASTABLE REFRACTORIES

REF ⑮ p 1-1

1971 PRODUCTION = 261,835 TONS

SAME REF & PAGE

$$\boxed{P_c = 0.043}$$ COMPOUND

$$1975\ \text{PRODUCTION} = (261,835)(1+.043)^4$$

$$= 309,860\ \text{TONS}$$

REF (144) p 48 INDICATES A FRACTIONAL UTILIZATION OF 80% FOR "STONE, CLAY & GLASS." SINCE NO SPECIFIC INFORMATION COULD BE LOCATED FOR CASTABLE REFRACTORIES IN PARTICULAR, WE WILL ASSUME THIS VALUE TO BE APPLICABLE.

$$\boxed{K = 0.80}$$

$$A = \frac{309,860}{.80} =$$

$$\boxed{A = 387,325\ \text{TONS}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper, Date 12/4/74

Source Castable Refractories

From Ref ㊲ p34, the IRS allowable depreciation for "other stone & clay products" which includes "ceramic insulating materials" is 15 yrs. Assuming twice the allowable,

$$P_B = \frac{1}{(2)(15)} = 0.033$$

$$\boxed{P_B = \underset{\text{simple}}{0.033}}$$

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Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/4/74

Source Castable Refractories

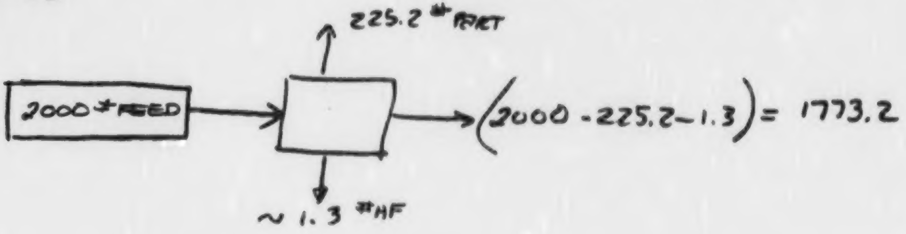
PARTICULATES

From Ref (75) p 8.5-1 TAB 8.5-1

Dryer	30
Crusher	120
Melting	50
Curing	.2
Molding	25
	225.2 #/TON of FEED

1.3 # HF/TON MELT

Since castable refractory mfg is accomplished by melting a feed stock & pouring this melt into molds, the feed/product ratio could be approximated as follows



$$\text{FEED}/\text{PRODUCT} = \frac{2000}{1773.2} = 1.128$$

So

$$E_U = 225.2 \ \#/\text{TON FEED} \times 1.128 \ \frac{\text{TON FEED}}{\text{TON PRODUCT}}$$

$$\boxed{E_{U_p} = 254 \ \#/\text{TON PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74

Source Castable Refractories

Ref ⑦⑤ indicates the following controlled emission factors & devices
p 8.5-1
TAB 8.5-1

Dryer – 0.3 #/ton w/ Baghouse
Crusher – 7.0 #/ton w/ Scrubber
Melting – 0.8 #/ton w/ Baghouse
Curing ~ 0
Molding – 0.3 #/ton w/ Baghouse

8.4 #/ton × 1.128 = 9.48

This corresponds to an overall η of

$$\eta = \frac{254 - 9.48}{254} = 96.3\%$$

$$\boxed{E_N = 9.48 \text{ \#/ton product}}$$

← E_N has been redefined. This value is incorrect. See p 4 of these calculations

E_S DETERMINATION

Ref ⑮ p 1-1 states 67 plants mfg 261,835 (1.01) tons

$$\text{Typ Plant Size} = \frac{(261{,}835)(1.01)}{(67)(8760)} = \text{TPH} = 0.451 \text{ TPH}$$

$$\frac{0.451}{0.8} \times 1.128 = \text{PWR} = 0.636 \text{ TPH} \cong 1272 \text{ \#/hr}$$

Ref ⑮ p 9-2 ff gives the name, location & % share of industry for each plant mfg refractories (all). Assuming the

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74

Source Castable Refractories

Same breakdown for castable refractories & considering only those whose share was greater than 1%, we det'n the following:

Missouri – 8.76%
Georgia – 7.31%
Pa – 5.47%
Ohio – 4.90
All others – 73.56%

Using Ref (84), (148) & gen'l pwr curve, the Allowable emissions are . . .

Mo. – 3.0
GA – 3.0
Pa – f (SCFM)
Ohio – 3.0
Others – 3.05

$$E_S = f(3.0\ \#/\text{HR})$$

$$\boxed{E_S = \frac{3.0}{(.451)(.8)} = 5.32\ \#/\text{TON}}$$

This value is less than E_N, the emission factor representing best level of control. For this case, the process weight reg's are more stringent than the best control can afford. This is understandable in light of the fact that the opposite set of circumstances has been found to exist for many plants.

However, the controlled emissions from the crushing op'n has been determined to be 7#/ton using a scrubber.

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Source Castable Refractories

This corresponds to an efficiency of

$$R = \frac{120-7}{120} = 94\%$$

Ref ⑦⑤ p 8.5-1 TAB 8.5-1 indicates that use of a cyclone could reduce emissions to 45 #/ton. This device could be used in series with a scrubber to obtain the following result

$$R = .94 = \frac{45-x}{45}$$

$$x = 2.7\ \#/\text{ton}$$

We feel that an controlled emission factor of 2.7 #/ton could be obtained. Therefore, EN will be redefined

$$E_N = (.3 + 2.7 + .8 + .3)(1.128) = 4.62\ \#/\text{ton}$$

$$\therefore \boxed{E_N = 4.62\ \#/\text{ton product}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/5/74

Source Castable Refractories

Fluorides

Ref (75) p8.5-1 TAB 8.5-1

$EU_{HF} = 1.3$ #/ton of melt

Since melt $\propto$ product

$$\boxed{EU_{HF} = 1.3 \text{ \#/ton product}}$$

Ref ⑮ indicates fluoride control of 95% using venturi scrubbers
p3-1,2

$E_N = 1.3(1-.95)$

$$\boxed{E_{N_{HF}} = 0.065 \text{ \#/ton product}}$$

There are no specific regs governing fluoride emissions from castable refractory plants

$\therefore \quad E_S = E_U$

$$\boxed{E_{HF} = 1.3 \text{ \#/ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoare Date 12/5/74

Source Castable Refractories

Since venturi scrubbers can generally be retrofit to existing installations, we will assume $E_{111d} = E_N$

$$\boxed{\underset{HF}{E_{111(d)}} = 0.065\ \#/\text{ton}}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/4/74

Source Ceramic Clay

REF (49) p 309 TAB 14-1

1968 PRODUCTION = 7.87×10^6 TONS

THIS IS BASED ON

① POTTERY & STONEWARE — 514,000 TONS
② FLOOR + WALL TILE — 577,000 TONS
③ FILTERS, CATALYST, CHEM'S, ETC - 3,781,000 TONS
④ FILLERS - 3,001,000 TONS

$\Downarrow$ 7.87×10^6 TONS

REF (93) p 145 TAB 9-1 STATES for the year 1963

① 511,166
② 434,493
③ 2,166,452
④ 2,435,605

$\Rightarrow 5.55 \times 10^6$ TONS

Assume simple GROWTH

$$\frac{7.87 - 5.55}{5 \text{ YRS}} = 0.464 \times 10^6 \text{ TONS/YR}$$

$$\text{PRODUCTION 1975} = 7.87 \times 10^6 + 7(.464 \times 10^6) = 11.1 \times 10^6$$

$$P_C = \frac{.464}{11.1} = 0.042$$

$$\boxed{P_C = 0.042}$$ SIMPLE

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Computation Sheet For Industrial Factors

Calculations Done By Horne. Date 12/4/74

Source Ceramic Clay

Ref (144) p48 indicates a K for "stone, clay & glass" = 80%

$$\boxed{K = 0.80}$$

$$A = \frac{11.1 \times 10^6}{.80} = 13.88 \times 10^6$$

$$\boxed{A = 13.88 \times 10^6 \text{ tons}}$$

From Ref (37) p 34, the IRS allowable depreciation for "other stone & clay products" is 15 yrs. Assuming twice the allowable

$$P_B = \frac{1}{2(15)} = 0.033$$

$$\boxed{P_B = 0.033}$$
Simple

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74

Source Ceramic Clay

Particulates

Ref ⑦⑤ p8.7-1 TAB 8.7-1 indicates

Drying — 70 #/ton
Grinding — 76 #/ton
Storage — 34 #/ton
} per unit input

Ref ④⑦ p 125 states that

All mat'l is dried
60% of mat'l is ground

We will assume Quantity Handled = Quantity Stored

$$\therefore E_U' = 70 + .6(76) + 34 = 149.6 \ \#/\text{ton}_{\text{input}}$$

No direct information could be found regarding the feed/product ratio. We will, therefore, use that det'd for brick & related clay products mfg — 1.173

$$E_U = 149.6 \ \#/\text{ton}_{\text{input}} \times 1.173 \ \frac{\text{ton input}}{\text{ton output}} = 175.5 \ \#/\text{ton}$$

$$\boxed{E_U = 175.5 \ \#/\text{ton product}}$$

Ref ⑦⑤ p 8.7-1 indicates a control efficiency = 90% can be attained using a cyclone & scrubber. However, we feel that a transfer of technology from Brick & Clay mfg is feasible. This would employ a cyclone followed by a fabric filter. Ref ⑱ p 5-2 TAB 5-1 indicates control = 99%

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/4/74

Source Ceramic Clay

for blending, storage & grinding

$$\therefore E_N = 175.5\,(1-.99) = 1.755$$

$$\boxed{E_{N_p} = 1.755 \text{ \#/TON PRODUCT}}$$

Since we have no direct information on typical plant size, we will assume the same as brick & related clay products mfg. This should be a valid judgement since the mat'ls, operations & market are quite similar

TYP SIZE ≈ 4 TPH Capacity

Applying a feed/product ratio of 1.173

PWR ≈ 4.7 TPH ≈ 9400 #/HR

Since we do not have the geographical distribution of plants & plant sizes, we will use the generalized process weight rate curve.

Ref (84) + (148)

Allowable = 11.0 #/HR

$$E_S = \frac{11.0}{4.0} = 2.75 \text{ \#/ton}$$

$$\boxed{E_{S_p} = 2.75 \text{ \#/ton PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74

Source Ceramic Clay

NO_x

No published information on NO_x emissions could be located. However, a great deal of similarity exists between ceramic clay mfg & brick & clay mfg. The same raw mat'ls (kaolinite + montmorillonite) are kiln-dried in similar type kilns. We will assume, therefore, until more accurate info is det'd, that the emission factors for NO_x emissions from ceramic clay are the same as for brick + related clay.

$$\boxed{EU_{NO_x} = 0.465 \text{ \#/ton}}$$

$$\boxed{EN_{NO_x} = 0.233 \text{ \#/ton}}$$

$$\boxed{ES_{NO_x} = 0.465 \text{ \#/ton}}$$

Fluorides

For the same reasons as mentioned above we will assume fluoride emissions to be the same as as for brick + clay mfg

$$\boxed{EU_{F^-} = 1.0 \text{ \#/ton}}$$

$$\boxed{EN_{F^-} = 0.30 \text{ \#/ton}}$$

$$\boxed{ES_{F^-} = 1.0 \text{ \#/ton}}$$

$$\boxed{E_{111(d)_{F^-}} = 0.3 \text{ \#/ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/4/74

Source CERAMIC Clay

ACID MIST

No direct information on emissions of ACID mist could be found. However, Stern (Ref (217) p 138) states An HCl emission of over 200 #/HR of HCl AT A "large fused silica furnace".

Ref ⑱ p 2-8 indicates that brick firing kilns are typically 50 - 250 TPD. Assuming the large plant production applies,

$$E_U = \frac{200(24)}{250} = 19.2 \ \frac{\#\ \text{HCl}}{\text{TON PRODUCT}}$$

$$\boxed{EU_{HCl} = 19.2 \ \#/\text{TON PRODUCT}}$$

Ref (217) p 138 indicates control by wet scrubbing
A transfer of technology from HCl production, which also uses wet scrubbing to control acid mist emissions shows that an $\eta = 96.7\%$ can be obtained
See Ref (142) p 13
+
Calculation sheet for "Hydrochloric Acid" done by Hopper for this project

$$E_N = 19.2(1-.967) = \boxed{0.634 \ \#/\text{ton} = EN_{\text{ACID MIST}}}$$

Since there are no regulations governing acid mist emissions, $E_S = E_U$

$$\boxed{E_S = 19.2 \ \#/\text{ton}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/4/74

Source Ceramic Clay

$E_{II(d)}$

Wet scrubbers can readily be retrofit to existing installations.

$$\therefore E_{III(d)} \equiv E_N$$

$$\boxed{E_{III(d)} = 0.634 \ \#/\text{ton}}$$

Summary

	E_U	E_N	E_S	$E_{II(d)}$
Part.	175.5	1.755	2.75	—
NO_x	.465	0.233	.465	—
Fl^-	1.0	.30	1.0	.30
Acid Mist	19.2	.634	19.2	.634

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/7/75

Source Clay Sintering

Very little information could be located regarding industrial factors for this industry. In fact, no production information could be found. We will, therefore, estimate a value & relate the value to some known facts to determine if the value appears reasonable.

Ref (222) p 7-41 indicates that a typical plant could produce 420 tons/day of product

This same Ref indicates "While the processes for sintering fly ash & clay are generally similar...."

We will ASSUME, until better info is available that the number of clay sintering plants & fly ash sintering plants are equal.

Ref (236) p VII-32 indicates that there are 5 fly ash sintering plants.

$$(5)(\underset{\uparrow \text{Assumption}}{350})(420) = 0.74 \times 10^6 \text{ tons of product}$$

We will assume this to be 1975 capacity

$$\boxed{A = 0.74 \times 10^6 \text{ tons product}}$$

In order to determine if this # appears reasonable, we will make the following analysis:

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 1/7/75

Source Clay Sintering

From Ref ㉕, in 1972, 28.6×10^6 tons of clay were handled

$$\% \text{ Sintered} \approx \frac{.74}{28.6} = 2.6\%$$

If the % were much higher than this, one would expect more discussion in the literature. This value may even be too high.

We will assume that K, P_C, P_B are identical to the brick & related clay product industry (See "Industrial Factors - Brick & Related Clay Products")

$$\boxed{K = 0.80}$$

$$\boxed{P_C = 0.027}$$ simple

$$\boxed{P_B = 0.033}$$ simple

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/2/74

Source Clay Sintering

Ref ⓶⓶⓶ p 7-39 INDICATES

$E_U = 40 \text{ LB/TON}$ (CLAY MIXED WITH COKE)
$E_U = 12 \text{ LB/TON}$ (NATURAL CLAY)

If we ASSUME A 50/50 USAGE RATE

$$E_U = \frac{40+12}{2} = 26$$

$$\boxed{E_{U_P} = 26 \ \text{LB} / \text{TON PRODUCT}}$$

If we ASSUME (AS we did with fly ASh sintering) ~~that~~ the use of A baghouse or ESP CAN reduce emissions by 99.9%

$$E_N = (1-.999)(26) = \boxed{0.026 \ \text{LB}/\text{TON PRODUCT} = E_{N_P}}$$

FROM Ref (215) we found ~~that~~ clay comes from 47 states; however, the majority (30-35%) comes from Georgia (10.4%), Texas (8.7%), Ohio (6.9%), N.C. (~5%). If we ASSUME ~~that~~ the clay sintering plants are located proportionately in these 4 STATES & THE FEED/PRODUCT RATIO IS AS FOLLOWS:

Ref (222) p 7-41

$F/P = 560/420 = 1.333$
$F/P = 35/26 = 1.35$
$\text{AVG} = 1.34$

Then using Refs (84) + (148)

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 1/7/75

Source Clay Sintering

for $\frac{420}{24}(2000)(1.34) = \text{PWR} = 46{,}900\ \text{LB/HR}$

Georgia - 34.2 LB/HR
Texas - 62.5 LB/HR
Ohio - 34.2 LB/HR
N.C. - 34.2 LB/HR

$$E_{Sp} = f\left[\frac{10.4}{31}(34.2) + \left(\frac{8.7}{31}\right)(62.5) + \left(\frac{6.9}{31}\right)(34.2) + \left(\frac{5}{31}\right)(34.2)\right]$$

$$= f(11.47 + 17.54 + 13.13) = f(42.1)$$

$$E_S = \frac{42.1\ \text{LB/HR}\ (24)}{420} = 2.41\ \text{LB/TON PRODUCT}$$

$$\boxed{E_{Sp} = 2.41\ \text{LB/TON PRODUCT}}$$

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Computation Sheet For. Industrial Factors

Calculations Done By Homer Date 1/7/75

Source Fly Ash Sintering

REF ㉕② P

Ref (252) P

1972 PRODUCTION = 7.576×10^6 TONS

REF (236) p VII-32

5 plants in the US. 200 TPH, 24 hrs/DAY, 7 days/WK

$$\text{CAPACITY} = (5)(200)(8760) = 8.76 \times 10^6$$

$$K = \frac{7.576}{8.76} = 0.86$$

$$\boxed{K = 0.86}$$

We will assume that the growth of fly ash sintering will PARALLEL THAT of LARGE UTILITY BOILERS FROM WHICH THE RAW MAT'L COMES. FROM OUR ANALYSIS of fossil-fueled boilers (SEE "INDUSTRIAL FACTORS - BOILERS P15),

$$\boxed{P_C = 0.055c}$$

$$A = (8.76 \times 10^6)(1 + .055)^3 = 10.29 \times 10^6$$

$$\boxed{A = 7.68 \times 10^6 \text{ TONS PRODUCT}}$$

P_2 of these calcs INDICATES A FEED/PRODUCT RATIO OF 1.34

So

$$A = 10.29 \times 10^6 / 1.34$$

$$= 7.68 \times 10^6$$

From Ref (57) p34, the IRS allowable depreciation for "other stone & clay products" is 15 YRS. Assuming twice the allowable,

$$P_B = \frac{1}{(2)(15)} = .033$$

$$\boxed{P_B = 0.033}$$ simple

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Computation Sheet For Emission Factors

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Source Fly Ash Sintering

Ref ⑦⑤ p 8.8-2 TAB 8.8-1

$$\boxed{E_{U_p} = 110 \text{ LB/TON PRODUCT}}$$

REF 236 p VII-32 STATES THAT EXISTING PLANTS USE EITHER A BAGHOUSE OR ESP DUE TO FINE PARTICULATE EMISSION. NO CONTROL η IS STATED. WE WILL ASSUME THAT AN η = 99.9% CAN BE OBTAINED

$$E_{N_p} = (1-.999)(110) = .11 \text{ LB/TON}$$

$$\boxed{E_{N_p} = .11 \text{ LB/TON PRODUCT}}$$

Ref (236) p VII-32 INDICATES A TYPICAL THROUGHPUT RATE OF 200 TPH

$$200(2000) = 400,000 \text{ LB/HR}$$

From the same Ref, full scale plants are located in the following STATES, NY, PA, MICH

There are 5 plants in the U.S. but we will assume that 33% of the capacity exists in each of the three abovementioned plants.

From Refs (84) & (148) for A PWR = 400,000 LB/HR

N.Y. 62.5 LB/HR

PA. Ref = f (SCFM)

Ref (236) p VII-32 SCFM AVG = 15,000 SCFM

$$\therefore \text{Reg} = 0.04 \text{ gr/SCF}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 1/2/74

Source Fly Ash Sintering

$$\frac{\left(.04\ \frac{gr}{scf}\right)\left(15{,}000\ \frac{scf}{min}\right)\left(60\ \frac{min}{hr}\right)}{7000\ gr/lb} = 5.14\ \text{lb/hr}$$

It would appear that this reg cannot be met in this case. Assume = to the avg of N.Y. & MICH

Michigan

58.0 lb/hr

$$62.5 + 58.0\ /2 = 60.2\ \text{lb/hr}$$

Ref (222) p 7-41

A. $\frac{\text{Feed}}{\text{Product}} = \frac{560}{420} = 1.333$

B F/P = $35/26 = 1.35$

Avg = 1.34

$$E_s = \frac{60.2\ \text{lb/hr}\,(1.34)}{200} = 0.40\ \text{lb/ton}$$

$$\boxed{E_{s_p} = 0.40\ \text{lb/ton product}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/17/74

Source Coal Cleaning: Thermal Drying

K:

Ref. 010 p. 3-5

Production in 1969 = $67.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}$

Ref. 010 p. 3-6

192 Thermal Drying Units (1969)

Ref. 010 p. 8-3

119 Coal Cleaning Plants with Thermal Drying (1969)

Ref. 010 p. 8-14

$150 \frac{\text{TONS}}{\text{HR}}$, Capacity for typical thermal dryer (1969)

$$\text{Plant Production} = \frac{67.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{119 \text{ plants}} = .56 \times 10^6 \frac{\text{TONS}}{\text{YR}} / \text{Plant}$$

$$\text{Capacity} = \left(150 \frac{\text{TON}}{\text{HR}} / \text{Dryer}\right)\left(\frac{192 \text{ Dryers}}{119 \text{ Plant}}\right)\left(24 \frac{\text{HRS.}}{\text{DAY}}\right)\left(250 \frac{\text{DAYS}}{\text{YR}}\right) = 1.45 \times 10^6 \frac{\text{TONS}}{\text{YR}} / \text{PLANT}$$

$$K = \frac{.56 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{1.45 \times 10^6 \frac{\text{TONS}}{\text{YR}}} = .39$$

This value does not seem reasonable, unless it is assumed that every thermal drying plant has .7 thermal dryers idle on the average. For this reason we assumed that 24 hrs./day was an unrealistic assumption and that two eight hour shifts /day (16 hrs/day) was more reasonable.

Therefore $K = (.39)\left(\frac{24}{16}\right) = .59$ $\boxed{K = .59}$

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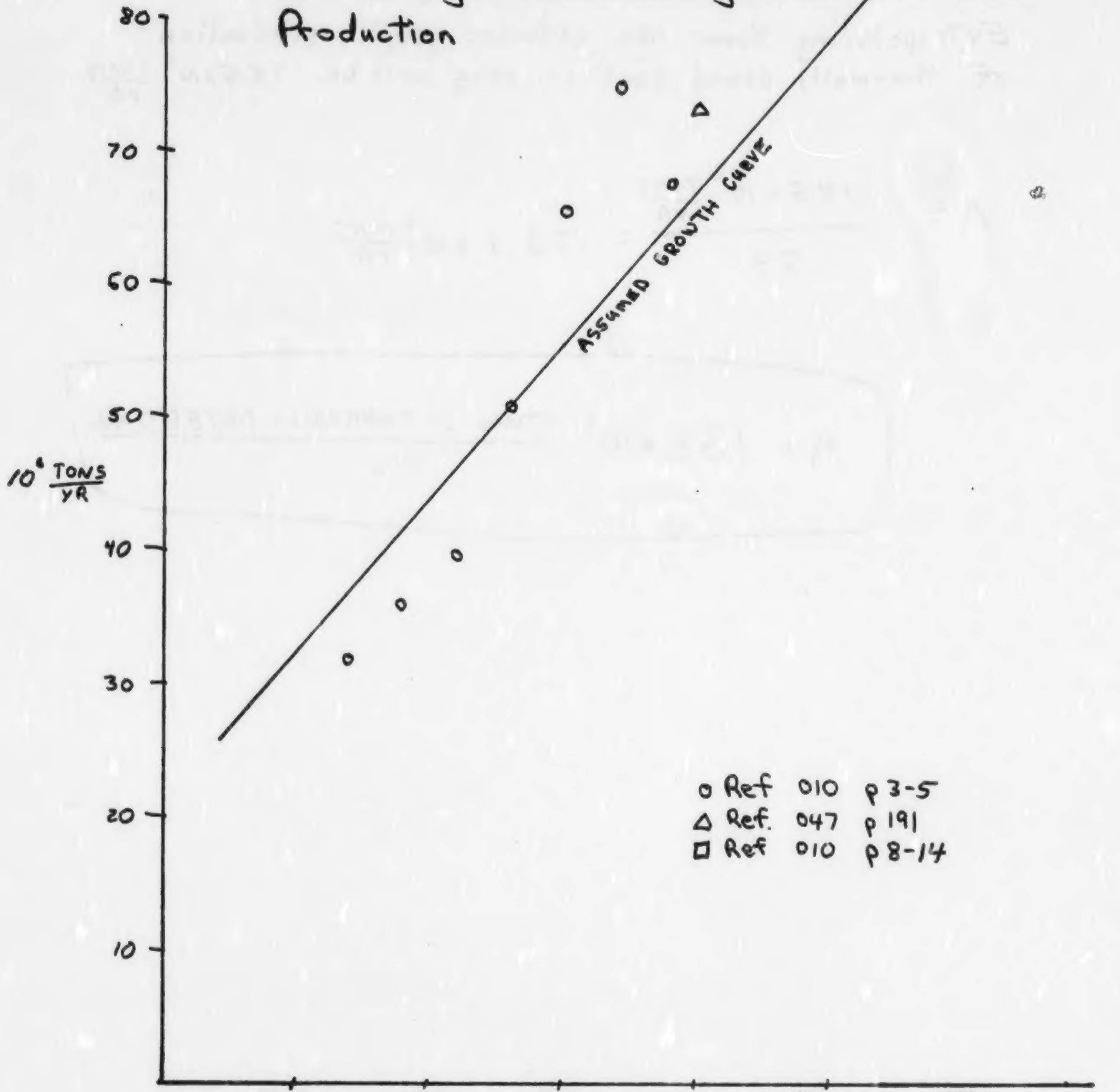
Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying



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Computation Sheet For Industrial Factors

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Source Coal Cleaning: Thermal Drying

Extrapolating from the attached graph, production of thermally dryed coal in 1975 will be $78.5 \times 10^6 \frac{\text{TONS}}{\text{YR}}$

$$A = \frac{78.5 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{.59} = 133.1 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$\boxed{A = 133 \times 10^6 \frac{\text{TONS OF THERMALLY DRYED COAL}}{\text{YR}}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

P_c Ref 010 lists the production growth of coal cleaning by thermal drying. The attached graph shows the production curve from 1955 to 1980. Simple growth is assumed. Based on an estimated production in 1975 of 78.5×10^6 TONS we estimate a 2.9% growth rate.

From the year 1965 + 1975 there is an increase of approximately 23×10^6 TONS OF COAL THERMALLY DRIED.

$$\frac{23 \times 10^6 \text{ TONS}}{10 \text{ yrs}} = 2.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}$$

$$P_c = \frac{2.3 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{78.5 \times 10^6 \frac{\text{TONS}}{1975}} = .029$$

$$\boxed{P_c = \underset{\text{simple}}{.029}}$$

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Computation Sheet For Industrial Factors

Calculations Done By K. Tower Date 12/17/74

Source Coal Cleaning: Thermal Drying

P_B:

Ref 037 Section 10.0

This category describes the asset guideline period for equipment used in the mining and quarrying of metallic and non-metallic minerals and the milling beneficiation and other primary preparation of such materials.

Asset Guideline Period = 10 yrs.

P_B est $\longrightarrow$ 2 x IRS = 20 yrs

$$\frac{100\%\ \text{depreciation}}{20\ \text{yrs.}} = 5\%\ \text{simple}$$

$$\boxed{P_B = .050\ \text{simple}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

Particulates

From Ref 010 p. 3-5 we determined the relative percentage of the three main types of thermal dryers

Fluidized Bed — .61
Multi louvred — .15
Flash — .24

Rotary, Screen, Vertical Tray & Cascade were all assumed to be flash type dryers.

Ref 075 Table 8.9-1, p8.9-1 gives the following uncontrolled emission factors.

Type of Dryer	Uncontrolled Emissions lb/TON
Fluidized Bed	20
Flash	16
Multilouvred	25

E_u:

Fluidized Bed $(20\ ^{lb}/_{TON})(.61) = 12.20\ ^{lb}/_{TON}$

Flash $(16\ ^{lb}/_{TON})(.24) = 3.84\ ^{lb}/_{TON}$

Multilouvred $(25\ ^{lb}/_{TON})(.15) = 3.74\ ^{lb}/_{TON}$

$19.78\ ^{lb}/_{TON}$

$\boxed{E_u = 19.8\ ^{lb}/_{TON} \text{ of coal dryed}}$

Ref 075 Table 8.9-1, p. 8.9-1 specifies a 99-99.9% control of thermal dryers with the use of a wet scrubber following cyclones. We assumed a 99.5% efficiency

$$E_N = .005 \times E_u = .005 \times 19.8\ ^{lb}/_{TON} = .099\ ^{lb}/_{TON}$$

$\boxed{E_N = .099\ ^{lb}/_{TON} \text{ of coal dryed}}$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/20/74

Source Coal Cleaning: Thermal Drying

E_N (con'd) Ref 237, p. 2 gives the recommended new source Federal standard for emissions for thermal dryers.

$E_{Allowable} = .031\ gr/dscf$

$$E_N = \frac{(.031\ gr/scf)(22{,}400\ scf/ton)^{*}}{7000\ gr/lb} = .099\ \frac{lbs\ emissions}{ton\ coal\ dryed}$$

* Ref 010, p. 3-8

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning : Thermal Drying

SO_x: We assumed that the total SO_x emissions were the result of the fuel burned to operate the dryers

Ref 043 p. 219

$230.8 \frac{\text{BTU req'd}}{\text{lb coal Dryed}}$

Ref 075 Table 1.1-2, p. 1.1-3

$38S \frac{\text{lbs S}}{\text{ton coal burned}}$ for $10 - 100 \times 10^6 \frac{\text{BTU}}{\text{HR}}$ Dryers

Ref 010 p. 8-14

Average thermal dryer now in operation $150 \frac{\text{TONS}}{\text{HR}}$

$$\left(230.8 \frac{\text{BTU}}{\text{lb coal}}\right)\left(150 \frac{\text{TONS}}{\text{HR}}\right)\left(2000 \frac{\text{lbs}}{\text{TON}}\right) = 69.2 \times 10^6 \frac{\text{BTU}}{\text{HR}}$$

This verifies $38S \frac{\text{lbs } SO_2}{\text{ton coal burned}}$

Ref 022 p. 4-4 Table 4-2

Average %S in coal = 2%

$\therefore \frac{\text{lbs } SO_2}{\text{ton coal burned}} = 76$ We assumed all the S is converted to SO_2

Ref 022 Table 4-1, p 4-2

$26.2 \times 10^6 \frac{\text{BTU}}{\text{TON COAL BURNED}}$

$$\frac{\left(230.8 \frac{\text{BTU}}{\text{lb COAL DRYED}}\right)\left(2000 \frac{\text{lbs}}{\text{TON COAL DRYED}}\right)\left(76 \frac{\text{lbs } SO_2}{\text{TON COAL BURNED}}\right)}{\left(26.2 \times 10^6 \frac{\text{BTU}}{\text{TON COAL BURNED}}\right)} = 1.34 \frac{\text{lbs } SO_2}{\text{TON COAL DRYED}}$$

$$\boxed{E_4 = 1.34 \frac{\text{lbs } SO_2}{\text{TON COAL DRYED}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/18/74

Source Coal Cleaning: Thermal Drying

SO_x (con'd)

Ref 101, p 9-3 shows that coal with a sulfur content as low as 0.5% can be obtained. An economic study should be made to determine the best control mechanism. We assumed the most feasible method to control sulfur emissions would be to reduce the average S content of the coal used for fuel to 0.5% S.

$$E_N = \left(\frac{0.5}{2.0}\right)(E_u)$$

$$= \left(\frac{0.5}{2.0}\right)\left(1.34 \frac{\text{lbs } SO_x}{\text{TON COAL DRYED}}\right)$$

$$= 0.33 \frac{\text{lbs } SO_x}{\text{TON COAL DRYED}}$$

$$\boxed{E_N = 0.33 \frac{\text{lbs } SO_x}{\text{TON COAL DRYED}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/19/74

Source Coal Cleaning: Thermal Drying

E_s:

Ref 010 p8-5 Table 9

State	Annual Tonnage of Coal Dryed (Thermally) [1969]	% of Total	# of Thermal Dryers, 1969 *
Illinois	10.7	15.9	39
Ohio	4.2	6.3	13
Pennsylvania	4.6	6.9	11
Virginia	10.1	15.1	19
West Virginia	30.8	45.9	82
		90.1	

*Ref 010, p8-4 Table8

As shown these 5 states constituted 90.1% of all the coal thermally dryed in 1969. We are basing E_s on just these five states.

Illinois $$\frac{\left(10.7 \times 10^6 \frac{\text{TONS}}{\text{YR}}\right)\left(2000 \frac{\text{lbs}}{\text{TON}}\right)}{(39 \text{ plants})\left(4000 \frac{\text{hrs}}{\text{yr}}\right)} = 137{,}179 \frac{\text{lbs}}{\text{hr.}}$$ $\frac{\text{Production}}{\text{Plant}}$

$$\left(69 \frac{\text{TONS}}{\text{HR}}\right)\left(2000 \frac{\text{lb}}{\text{TON}}\right) = 137{,}179 \frac{\text{lbs}}{\text{hr.}}$$

K=.59 $$\frac{137{,}000 \frac{\text{lbs}}{\text{YR}}}{.59} \times 1.0 \frac{\text{lb feed}}{\text{lb prod.}} = 232{,}203 \frac{\text{lbs coal dryed}}{\text{hr}}$$ INPUT CAPACITY

WE ASSUMED THE FEED TO PRODUCT RATIO (F/P) TO BE EQUAL TO 1.0

E_s regulations for state are taken from Ref. 084 & Ref 148

For Illinois 232,000 $\frac{\text{lbs}}{\text{hr}}$ Input Capacity, 32 $\frac{\text{lbs}}{\text{hr}}$ emission allowed

$$E_{s_{\text{ILL.}}} = \left(\frac{32 \frac{\text{lbs}}{\text{hr}}}{69 \frac{\text{TONS}}{\text{HR}}}\right)(.159) = \underline{\underline{.074 \frac{\text{lbs emissions}}{\text{TON COAL DRYED}}}}$$

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Computation Sheet For Emission Factors

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Source Coal Cleaning: Thermal Drying

E_s (Con'd)

pt Ohio

$$\frac{4.2 \times 10^6 \frac{\text{TONS}}{\text{YR}}}{(13 \text{ Plants})\left(4000 \frac{\text{HRS}}{\text{YR}}\right)} = 80.8 \frac{\text{TONS}}{\text{HR}} / \text{PLANT}$$

$$\left(80.8 \frac{\text{TONS}}{\text{HR}}\right)\left(2000 \frac{\text{lbs}}{\text{TON}}\right) = 161{,}600 \text{ lbs/HR} \quad \text{Average Plant Production}$$

$$\frac{\left(161{,}600 \frac{\text{lbs}}{\text{HR}}\right)\left(1.0 \frac{\text{lb Feed}}{\text{lb Product}}\right)}{.59} = 273{,}898 \frac{\text{lbs coal dryed}}{\text{hr}} \quad \text{INPUT CAPACITY}$$

$E_{\text{Allowable}}$ in Ohio for $274{,}000 \frac{\text{lbs}}{\text{hr}}$ Input Capacity $= 55 \frac{\text{lbs}}{\text{hr.}}$
(Ref 084 and Ref 148)

$$E_{s_{\text{OHIO}}} = \frac{\left(55 \frac{\text{lbs}}{\text{TON}}\right)}{\left(81 \frac{\text{TONS}}{\text{HR}}\right)}(.063) = \underline{\underline{.043 \frac{\text{lbs emissions}}{\text{TON COAL DRYED}}}}$$

Pennsylvania

Assume $E_{s_{\text{Penn.}}} = E_{s_{\text{average}}}$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/19/74

Source Coal Cleaning: Thermal Drying

E_S (con'd):

PT Virginia

$$\frac{10.1 \times 10^6 \ \frac{\text{TONS}}{\text{YR}}}{\left(19 \text{ Plants}\right)\left(4000 \frac{\text{HRS}}{\text{YR}}\right)} = 132.9 \ \frac{\text{TONS}}{\text{HR}} / \text{PLANT}$$

$$\left(132.9 \ \frac{\text{TONS}}{\text{HR}}\right)\left(2000 \frac{\text{lbs}}{\text{TON}}\right) = 265,800 \ \frac{\text{lbs}}{\text{HR}} \quad \text{Average Plant Production}$$

$$\frac{\left(265,800 \frac{\text{lbs}}{\text{HR}}\right)\left(1.0 \frac{\text{lb Feed}}{\text{lb Product}}\right)}{.59} = 450,508 \ \frac{\text{lbs coal dryed}}{\text{hr}} \quad \text{INPUT CAPACITY}$$

$E_{\text{Allowable}}$ in Virginia for 450,508 lb/HR Input Capacity = 61 lbs/Hr Allowable (Ref 084 and Ref 148)

$$E_{S_{\text{Virginia}}} = \left(\frac{61 \ \frac{\text{lbs}}{\text{HR}}}{199 \ \frac{\text{TONS}}{\text{HR}}}\right)\left(.151\right) = .046 \ \frac{\text{lbs emissions}}{\text{TON coal dryed}}$$

West Virginia

$$\frac{30.8 \times 10^6 \ \frac{\text{TONS}}{\text{YR}}}{\left(82 \text{ plants}\right)\left(4000 \frac{\text{HRS}}{\text{YR}}\right)} = 93.9 \ \frac{\text{TONS}}{\text{HR}} / \text{Plants}$$

$$\left(93.9 \ \frac{\text{TONS}}{\text{HR}}\right)\left(2000 \frac{\text{lbs}}{\text{TON}}\right) = 187,800 \ \text{lbs/HR} \quad \text{Average Plant Production}$$

$$\frac{93.9 \ \frac{\text{TONS}}{\text{HR}}}{.59} = 159.2 \ \frac{\text{TONS}}{\text{HR}} \quad \text{Average Plant Capacity}$$

Ref 010, p 3-8 states for an average dryer there is 22,400 standard cubic feet of dry air per ton of coal.

$$\frac{\left(159.2 \ \frac{\text{TONS}}{\text{HR}}\right)\left(22,400 \frac{\text{SCF}}{\text{TON}}\right)}{\left(60 \frac{\text{min}}{\text{HR}}\right)} = 59,435 \text{ SCFM} \quad \text{for typical plant}$$

$E_{\text{allowable, Existing Sources, W. Virginia}}$ = 0.12 grains/SCF for Dryers with $\leq$ 120,000 SCF/MIN

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/19/74

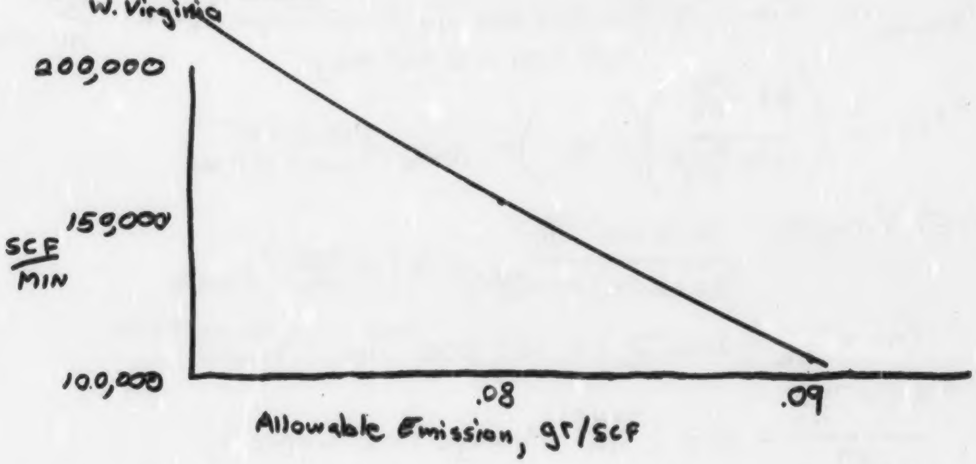
Source Coal Cleaning: Thermal Drying

E_s (Con'd)
PT

$$E_{s\,\substack{\text{existing}\\ \text{W.Virginia}}} = \frac{\left(0.12\ \frac{\text{gr}}{\text{SCF}}\right)\left(2000\ \frac{\text{lbs}}{\text{TON}}\right)\left(22{,}400\ \frac{\text{SCF}}{\text{TON}}\right)}{\left(14\times10^{6}\ \frac{\text{gr}}{\text{ton}}\right)} = .38\ \frac{\text{lbs}}{\text{ton coal dryed}}$$

$$E_{s\,\substack{\text{existing}\\ \text{W.Virginia}}} = \left(.38\ \frac{\text{lbs}}{\text{TON}}\right)\left(.459\right) = .174\ \frac{\text{lbs}}{\text{TON}}$$

E_s Allowable New Sources W. Virginia



Ref 010, 8-14 New Dry Capacity will be 400 TON/HR

$$\frac{\left(400\ \frac{\text{TONS}}{\text{HR}}\right)\left(22{,}400\ \frac{\text{SCF}}{\text{TON}}\right)}{\left(60\ \frac{\text{min}}{\text{HR}}\right)} = 149{,}333\ \text{SCFM For Typical NEW PLANT}$$

$$E_{\text{Allowable New Source}} = .0815\ \text{gr/SCF}$$

$$E_{s\,\substack{\text{New Sources}\\ \text{W.Virginia}}} = \frac{\left(.0815\ \text{gr/SCF}\right)\left(2000\ \frac{\text{lbs}}{\text{TON}}\right)\left(22{,}400\ \frac{\text{SCF}}{\text{TON}}\right)}{14\times10^{6}\ \text{gr/ton}} = .261\ \text{lbs/ton}$$

$$E_{s\,\substack{\text{New}\\ \text{W.Virg.}}} = (.261)(.459) = .120\ \frac{\text{lbs}}{\text{TON}}$$

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Computation Sheet For Emission Factors

Calculations Done By K.Tower Date 12/19/74

Source Coal Cleaning : Thermal Drying

E_S (con'd)
PT

$$E_{S\,\substack{\text{New Source}\\ \text{W. Virginia}}} = \left(.26\,\frac{\text{lbs}}{\text{ton}}\right)\left(.459\right) = .119\,\frac{\text{lbs}}{\text{TON}} \qquad E_{S\,\text{New Source}} = .119\,\frac{\text{lbs}}{\text{ton}}$$

We make the assumption that all states but ILL., OHIO, Virg. & W. Virg. with thermal dryers have an E_S equal to the average.
percentage of

$$E_{S_{\text{EXISTING}}} = E_{S_{\text{ILL}}} + E_{S_{\text{OHIO}}} + E_{S_{\text{Virg}}} + E_{S_{\substack{\text{W.Virg.}\\ \text{Existing}}}} + E_{S_{\text{Existing}}}(.168)$$

$$E_{S_{\text{Existing}}} = \frac{.074\,\frac{\text{lbs}}{\text{TON}} + .043\,\frac{\text{lbs}}{\text{TON}} + .046\,\frac{\text{lbs}}{\text{TON}} + .174\,\frac{\text{lbs}}{\text{TON}}}{1-.168} = .405\,\frac{\text{lbs}}{\text{TON}}$$

$$\boxed{E_{S_{\substack{\text{Existing}\\ \text{Sources}}}} = .41\,\frac{\text{lbs PT}}{\text{TON COAL DRIED}}}$$

$$E_{S_{\text{New}}} = E_{S_{\text{ILL}}} + E_{S_{\text{OHIO}}} + E_{S_{\text{Virg.}}} + E_{S_{\substack{\text{W.Virg.}\\ \text{New}}}} + E_{S_{\text{Existing}}}(.168)$$

$$E_{S_{\text{New}}} = \frac{.074\,\frac{\text{lbs}}{\text{TON}} + .043\,\text{lbs}/\text{TON} + .046\,\text{lbs}/\text{TON} + .120\,\frac{\text{lbs}}{\text{TON}}}{1-.168} = .340\,\text{lbs}/\text{TON}$$

$$\boxed{E_{S\,\substack{\text{NEW}\\ \text{Sources}}} = .34\,\frac{\text{lbs PT}}{\text{TON COAL DRIED}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/20/74

Source Coal Cleaning: Thermal Drying

$E_{s\ SO_2}$ Ref 084 & Ref 148

State	Allowable SO_2 #SO_2/10^6 BTU	Allowable SO_2 #SO_2/TON COAL Dryed	*% of Total Tonnage Dryed 1969
Colorado	.3	.14	.01
Illinois	1.8_{Existing}; 1.2_{NEW}	$.83_{\text{Existing}}$; $.55_{\text{NEW}}$	.16
Indiana	1.2	.55	.03
Kentucky	3.2	1.48	.05
N. Dakota	3.0	1.39	.00
Ohio	2.9_{Existing}; 1.0_{NEW}	1.34_{Existing}; $.46_{\text{New}}$	.06
Pennsylvania	.46	.21	.07
Utah	1.53	.71	.01
Virginia	Ground Level		.15
W. Virginia	1.53	.71	.46

*Ref 010, p8-5

#SO_2/TON COAL DRYED was obtained by multiplying #SO_2/10^6BTU by the factor $230 \frac{\text{BTU}}{\text{lb coal}} \times 2000 \frac{\text{lbs}}{\text{TON}}$. Ref. 043, p219.

$$E_{S_{\text{Existing}}} = (.01) E_{S_{\text{COL}}} + (.16) E_{S_{\substack{\text{Ill}\\ \text{Existing}}}} + (.03) E_{S_{\text{IND}}} + (.05) E_{S_{\text{Kent.}}} + (.00) E_{S_{\text{NDak.}}} + (.06) E_{S_{\substack{\text{OHIO}\\ \text{Existing}}}} + (.07) E_{S_{\text{Penn.}}} + (.01)(E_{S_{\text{utah}}}) + (.15) E_{S_{\text{Existing}}} + (.46) E_{S_{\text{w.virg.}}}$$

We assumed $E_{S_{\text{virg}}} = E_{S_{\text{EXISTING}}}$

$$E_{S_{\text{Existing}}} = .0014 + .133 + .017 + .074 + .000 + .080 + .015 + .007 + .15\, E_{S_{\text{Existing}}} + .327$$

$$E_{S_{\text{Existing}}} = \frac{.654}{1-.15} = .769 \frac{\text{lbs}}{\text{TON}} \quad \boxed{E_{S_{\text{EXISTING}}} = .77 \frac{\text{lbs } SO_2}{\text{Ton Coal Dryed}}}$$

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Computation Sheet For Emission Factors

Calculations Done By K. Tower Date 12/20/74

Source Coal Cleaning: Thermal Drying

$E_{s_{SO_2}}$ (con'd)

$$E_{s_{New}} = (.01)E_{s_{Colo.}} + (.16)E_{s_{\substack{Ill\\New}}} + (.03)E_{s_{IND}} + (.05)E_{s_{Kent.}} + (.00)E_{s_{N.Dak.}} + (.06)E_{s_{\substack{OHIO\\NEW}}} + (.07)E_{s_{Penn.}} +$$

$$(.01)E_{s_{Utah}} + (.15)E_{s_{New}} + (.46)E_{s_{W.Virg.}}$$

$$E_{s_{New}} = .001 + .088 + .017 + .074 + .000 + .028 + .015 + .007 + (.15)E_{s_{NEW}} + .327$$

$$E_{s_{New}} = \frac{.557}{1-.15} = .655\,\frac{\text{lbs}}{\text{TON}} \qquad \boxed{E_{s_{\substack{New\\Sources}}} = .66\,\frac{\text{lbs }SO_2}{\text{TON COAL DRYED}}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/17/74

Source Fiberglass Mfg.

BECAUSE OF DIFFERENT EMISSIONS & PROCESSES, THIS INDUSTRY MUST BE BROKEN UP INTO TWO CATEGORIES

(a) TEXTILE PRODUCTS
(b) WOOL PRODUCTS

FROM REF (228) P 42 TAB 8.2

ESTIMATED 1975 PRODUCTION

(a) TEXTILE PRODUCTS = 725×10^6 LBS = 0.363×10^6 TONS
(b) WOOL PRODUCTS = 1518×10^6 LBS = 0.759×10^6 TONS

FROM REF (228) P 1

$$\boxed{K_{\substack{\text{TEXTILE}\\+\\\text{WOOL}}} = 0.70}$$ ← ASSUME TO BE THE SAME FOR TEXTILE & WOOL

$$A_{\text{TEXTILE}} = 0.363 \times 10^6 / 0.70 =$$

$$\boxed{A_{\text{TEXTILE}} = 0.519 \times 10^6 \text{ TONS}}$$

$$A_{\text{WOOL}} = 0.759 \times 10^6 / .70 = 1.084 \times 10^6$$

$$\boxed{A_{\text{WOOL}} = 1.084 \times 10^6 \text{ TONS}}$$

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Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 12/17/74

Source Fiberglass Mfg

From Ref (228) p 39

$$\boxed{P_{C_{\text{TEXTILE}}} = 0.122} \quad \text{CMPD}$$

$$\boxed{P_{C_{\text{WOOL}}} = 0.042} \quad \text{CMPD}$$

Ref (228) p 37 Depreciation period is quoted @ 8 years
Assume, that realistically twice this value would hold

$$\therefore P_B = \frac{100\%}{16\text{YRS}} = 6.25\%$$

$$\boxed{P_{B_{\substack{\text{TEXTILE}\\ \text{WOOL}}}} = 0.0625} \quad \text{simple}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/17/74

Source Fiberglass

PARTICULATES

REF (228) p 22 TAB 5.1 gives UNCONTROLLED emission factors for each process type as AVERAGE values

$$\boxed{Eu_{p_{\text{TEXTILE}}} = 84 \ \#/\text{TON PRODUCT}}$$

$$\boxed{Eu_{p_{\text{WOOL}}} = 96 \ \#/\text{TON PRODUCT}}$$

FOR WOOL PROCESS

Ref (228) discusses controls from A new (1971) O-C-F plant which "INCORPORATES the latest emission CONTROL MEASURES"

OCF will be replacing (eventually) ALL reverbatory furnaces WITH ELECTRIC MELT FURNACES. WE WILL ASSUME THAT ALL NEW & REPLACEMENT furnaces are of this type. REF (228) p 24

$\therefore \ En_{\text{furnace}} = 1.1 \ \#/\text{TON PRODUCT}$

$En_{\text{FORMING}} = f(88\% \ \eta)$ "By changing process CONDITIONS, USING A SCRUBBER AND A BAFFLED PENTHOUSE...." REF (228) p 28

$En_{\text{forming}} = 57.6(1-.88) = 6.91 \ \#/\text{TON PRODUCT}$

$En_{\text{OVEN}} = f(97\% \ \eta)$ "treated by incineration" Ref (228) p 28

$En_{\text{OVEN}} = (1-.97)(9.0) = 0.27 \ \#/\text{ton product}$

$En_{\text{cooler}} = f(85\% \ \eta)$ "controlled by water scrubbing" Ref (228) p 28

$En_{\text{cooler}} = (1-.85)(2.4) = 0.36 \ \#/\text{TON}$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/13/74

Source Fiberglass

$$E_{N_{P_{wool}}} = 8.64 \ \#/\text{ton}_{\text{PRODUCT}}$$

Note: REF (228) p19 This reference (& others) indicate that control of PARTICULATE EMISSIONS from the forming line is difficult. ∴ additional R+D control efforts WOULD BE REQ'D in THIS AREA.

FOR TEXTILE PROCESS

Ref (228) p 29ff OCF IS CONDUCTING AN R+D PROGRAM to DEVELOP AN ELECTRIC FURNACE for textile FIBER PLANTS. WE WILL ASSUME THAT BY 1985, THIS EFFORT WILL BE SUCCESSFUL

$$E_{N_{furnace}} = 1.1 \ \#/\text{ton}$$

Presently, no controls ARE USED ON the forming & curing lines & COOLING DOES NOT APPLY TO THIS PROCESS. WE WILL, HOWEVER, ASSUME A TRANSFER OF TECHNOLOGY FROM WOOL PLANTS BY employing THE SAME TYPE CONTROL DEVICES + EFFICIENCIES.

$$E_{N_{forming}} = 1.6(1-.88) = 0.192$$

$$E_{N_{curing}} = 5.6(1-.97) = 0.168$$

$$E_{N_{P_{TEXTILE}}} = 1.46 \ \#/\text{ton}_{\text{PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

$E_{S_{\text{PARTICULATE}}}$

IN 1972 THERE WERE 32 mfg plants in the U.S. REF ㉘228 p 40,41. P 42A INDICATES for 1972

WOOL PRODUCTION = 1343 x 10⁶ LBS

TEXTILE PRODUCTION = 493 x 10⁶ LBS

ASSUMING THAT THE TYPICAL WOOL PLANT IS EQUAL IN SIZE to the TEXTILE PLANT

$$\frac{(1343+493)\times 10^6}{(32)(8760)} = 6550 \text{ LB/HR (PRODUCTION)}$$

$$\text{CAP.} = \frac{6550}{0.7} = 9357 \text{ LB/HR} = 4.68 \text{ TPH}$$

REF (228) p 40+41 gives the # of employees in each plant in each State. Since we do not have PRODUCTION OR CAPACITY breakdowns, we will ASSUME plant size PROPORTIONAL to the # of employees

TOTAL EMPLOYEES = 20,377

STATE	%
Calif.	6.4
GA.	1.3
IND.	3.3
KANSAS	9.9
N.J.	8.3
N.Y.	0.1
N.C.	16.7
OHIO	18.3
Pa	5.8
RI	2.9
S.C.	14.5
Tenn	6.9
Tex	3.7
W.Va.	1.8

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By ______________________ Date ______________

Source Fiberglass

8 STATES CONTRIBUTE 87% of the production. WE WILL EVALUATE E_{S_P} FOR THESE 8 STATES

From Refs (89), (148) & (156) the Allowable emissions are

CAL - 9.59 lb/hr
KANSAS - 11.4
NJ. - 30.0
N.C. - 11.4
Ohio - 11.4
Pa - ASSUME AS THE AVG
S.C. - 11.4
Tenn - 9.4

$$E_{S_P} = \left[(.064)(9.59) + (.099)(11.4) + (.083)(30) + (.167)(11.4) + (.183)(11.4) + (.145)(11.4) + (.069)(9.4)\right] + (E_{S_P})(.19)$$

$$E_S = 0.614 + 1.129 + 2.49 + 1.904 + 2.086 + 1.653 + .649 + .19\,E_S$$

$$= 10.525 + .19\,E_S$$

$$E_{S_P} = 12.99 \text{ \#/hr}$$

$$E_{S_{P\,\text{WOOL}}} = \frac{12.99}{4.68} = 2.78$$

$$E_{S_{P\,\text{WOOL}}} = 2.78 \text{ \#/TON}$$

$$E_{S_{P\,\text{TEXTILE}}} = 2.78 \text{ \#/TON}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 2/18/74

Source Fiberglass

The Es for wool process cannot be attained with BACT

$\therefore E_S \equiv E_N$

$$\boxed{E_{S_{P_{WOOL}}} = 8.64 \text{ \#/ton product}}$$

However, E_N for textile process is more stringent than Es

$$\therefore \boxed{E_{S_{TEXTILE\, P}} = 2.78 \text{ \#/ton product}}$$

Summary of Particulate Emission Factors

	E_U	E_N	E_S
Textile	84.0	1.46	2.78
Wool	96.0	8.64	8.64

Emission factors for SO_2

Ref ⑦⑤ p 8.11-3 Tab 8.11-1 gives emission factors for SO_2

Since we do not know the % breakdown between regenerative & recuperative ovens, assume 50/50 split

$$E_{U_{SO_2\, TEX.}} = (29.6 + 2.7)/2 = 16.2$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

$$\boxed{E_{U_{SO_2}\,\text{TEXTILE}} = 16.2\ \text{\#/ton PRODUCT}}$$

Assume equal breakdown for wool process

$$E_{U_{SO_2}\,\text{WOOL}} = \frac{10.0+9.5+.04}{3} = 6.51$$

$$\boxed{E_{U_{SO_2}\,\text{WOOL}} = 6.51\ \text{\#/TON PRODUCT}}$$

As for particulates, the industry is going to electric furnaces. From Ref (55) p 8.11-3 TAB 8.11-1, E_U for electric furnaces for wool processing is 0.04 #/ton. So

$$\boxed{E_{N_{SO_2}\,\text{WOOL}} = 0.04\ \text{\#/TON PRODUCT}}$$

Assume that by 1985 R+D efforts for electric furnaces for textile processing is successful & the emission factor is the same as for wool.

$$\boxed{E_{N_{SO_2}\,\text{TEXTILE}} = 0.04\ \text{\#/TON PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

Only ILL, IND & NJ have gen'l process SO_2 reg. There are no fiberglass plants in ILL & IND & ~ 8.3% of capacity is located in N.J.

THE NJ reg is 2000 ppm

From Ref(228) p Appendix

Furnace airflow is between 4000 & 8000 SCFM.

Assuming 6000 SCFM,

$$\frac{\left(\frac{.002\ FT^3 SO_2}{FT^3\ gas}\right)\left(\frac{6000\ FT^3 gas}{MIN}\right)\left(60\ \frac{MIN}{HR}\right)\left(492°R\right)\left(64\ \frac{\# SO_2}{\# mole}\right)}{\left(530°R\right)\left(359\frac{FT^3 SO_2}{\# mole}\right)\left(4.68\ \frac{TON\ PRODUCT}{HR}\right)} = \frac{\# SO_2}{TON\ PRODUCT} = 25.5$$

Since this is greater than Eu for either process, then $Es_{SO_2} = Eu$

$$\boxed{Es_{SO_2\ TEXTILE} = 16.2\ \#/\text{TON PRODUCT}}$$

$$\boxed{Es_{SO_2\ WOOL} = 6.51\ \#/\text{TON PRODUCT}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

Summary of SO_2 Emission Factors

	E_U	E_N	E_S
Textile	16.2	0.04	16.2
Wool	6.51	0.04	6.51

Emission Factors For NO_x

Ref ⑦⑤ p8.11-3 Tab 8.11-1 gives emission factors for NO_x. Since we do not know the % breakdown between regenerative & recuperative ovens, assume 50/50 split

$$E_{U_{NO_x}\,\text{TEXTILE}} = \frac{9.2+29.2}{2} = 12.7\ \text{\#/ton} + 2.6\ \text{\#/ton} \left(\begin{matrix}\text{FROM}\\ \text{CURING}\\ \text{OVEN}\end{matrix}\right)$$

$$\boxed{E_{U_{NO_x}\,\text{TEXTILE}} = 15.3\ \text{\#}/\begin{matrix}\text{TON}\\ \text{PRODUCT}\end{matrix}}$$

Assume equal breakdown for wool process

$$E_{U_{NO_x}\,\text{WOOL}} = \frac{5.0+1.7+.27}{3} = 2.32\ \text{\#/ton} + \overset{\overset{\text{curing}}{\downarrow}}{1.1\ \text{\#/ton}} + \overset{\overset{\text{cooling}}{\downarrow}}{0.2}$$

$$\boxed{E_{U_{NO_x}\,\text{WOOL}} = 3.52\ \text{\#}/\begin{matrix}\text{TON}\\ \text{PRODUCT}\end{matrix}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

As was the case for particulate & SO_x, the industry is changing to electric furnaces. From Ref (95) p 8.11-3 TAB 8.11-1, E_U for electric furnaces is 0.27 #/ton. So .. 0.27+1.1+.2

$$\boxed{E_{N\,NO_x\,\text{wool}} = 1.57 \text{ \#/ton}_{\text{product}}}$$

Assume that by 1985, R+D efforts for electric furnaces for textile processing is successful & the emission factor is the same as for wool.
Then 0.27+2.6 = 2.87

$$\boxed{E_{N\,NO_x\,\text{textile}} = 2.87 \text{ \#/ton}_{\text{product}}}$$

Since there are no regs applicable to NO_x emissions from fiberglass plants $E_S = E_U$

$$\boxed{E_{S\,NO_x\,\text{wool}} = 3.62 \text{ \#/ton}_{\text{product}}}$$

$$\boxed{E_{S\,NO_x\,\text{textile}} = 15.3 \text{ \#/ton}_{\text{product}}}$$

Summary (NO_x)

	E_U	E_N	E_S
Textile	15.3	2.87	15.3
Wool	3.62	1.57	3.62

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Computation Sheet For Emission Factors

Calculations Done By Hayes Date 12/18/74

Source Fiberglass

CARBON MONOXIDE

We will follow with the same assumptions used to calculate the emission factors for part., $NO_x + SO_x$

REF ⑦⑤ p 8.11-3 TAB 8.11-1

$$EU_{CO_{TEX}} = \frac{1.1+.9}{2} = 2.0 + \overset{\text{curing}}{1.5}$$

$$\boxed{EU_{CO_{TEXTILE}} = 3.5 \ \#/\text{TON PRODUCT}}$$

$$EU_{CO_{WOOL}} = \frac{.25+.25+.05}{3} = 0.183 + \overset{\text{curing}}{1.7} + \overset{\text{cooling}}{0.2}$$

$$\boxed{EU_{CO_{WOOL}} = 2.08 \ \#/\text{TON PRODUCT}}$$

Same page & Ref using electric furnaces, $E_{N_{WOOL}} = .05 + 1.7 + .2$

$$\boxed{EN_{CO_{WOOL}} = 1.95 \ \#/\text{TON PRODUCT}}$$

$EN_{TEX} = .05 + 1.5 = 1.55$

$$\boxed{EN_{CO_{TEXTILE}} = 1.55 \ \#/\text{TON PRODUCT}}$$

Since there are no regs applicable to CO emissions, $E_S = EU$

$$\boxed{ES_{CO_{TEXTILE}} = 3.5 \ \#/\text{TON PRODUCT}} \qquad \boxed{ES_{CO_{WOOL}} = 2.08 \ \#/\text{TON PRODUCT}}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fibreglass

Summary (CO)

	Eu	E.N.	Es
Textile	3.5	1.55	3.5
Wool	2.08	1.95	2.08

Hydrocarbon Emission Factors

From Ref (75) p 8.11-3 TAB 8.11-1

$$EU_{HC_{wool}} = 0.09 + 3.3 = 3.39$$

$$\boxed{EU_{HC_{wool}} = 3.39 \ \#/\text{ton produced}}$$ curing + cooling

It would appear that there are no H/C emissions from textile processing

Since the wool curing process would be controlled by incineration to eliminate particulates, H/C emissions would also be eliminated. The η was stated @ 97%

$$EN_{HC_{wool}} = (1-.97)(3.39) = 0.102 \ \#/\text{ton}$$

$$\boxed{EN_{HC_{wool}} = 0.102 \ \#/\text{ton produced}}$$

Since there are no regs applicable to these H/C emissions, Es = Eu

$$\boxed{ES_{HC_{wool}} = 3.39 \ \#/\text{ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/18/74

Source Fiberglass

FLUORIDES

We will follow with the same assumptions used to CALCULATE THE EMISSION FACTORS FOR PART, NO_x & SO_x & CO

REF ⑦⑤ p 8.11-3 TAB 8.11-1

$$E_{U_{F^-}\,\text{TEXTILE}} = \frac{3.8 + 12.5}{2} = 8.15$$

$$\boxed{E_{U_{F^-}\,\text{TEXTILE}} = 8.15 \ \#/\text{TON PRODUCED}}$$

$$E_{U_{F^-}\,\text{WOOL}} = \frac{0.12 + .11 + .02}{3} = 0.08 \ \#/\text{ton}$$

$$\boxed{E_{U_{F^-}\,\text{WOOL}} = 0.08 \ \#/\text{ton}}$$

As was mentioned previously, the industry is switching to electric furnaces. Assuming that R+D efforts to develop electric furnaces for textile processing are successful by 1985 & the emission factor is the same as for wool processing

$$\boxed{E_{N_{F^-}\,\text{TEXTILE}} = 0.02 \ \#/\text{ton}}$$

$$\boxed{E_{N_{F^-}\,\text{WOOL}} = 0.02 \ \#/\text{ton}}$$

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Source Fiberglass

Since there are no specific fluoride regs, $E_S = E_U$

$$\boxed{E_{S_{F^-}} \underset{\text{TEXTILE}}{} = 8.15 \ \#/\text{ton}}$$

$$\boxed{E_{S_{F^-}} \underset{\text{WOOL}}{} = 0.08 \ \#/\text{ton}}$$

$E_{111(d)}$

The use of electric furnaces is not a feasible "retrofit" technique. There has been no demonstrated control technology for F⁻ control from furnaces in the fiberglass industry. However, Ref (234) p 3-224, indicates wet scrubbing could be used for a fluoride emissions from GLASS furnaces with an efficiency of 99%. We will assume this transfer of technology to be feasible.

$$E_{111d_{F^-}} \underset{\text{TEXTILE}}{} = (1-.99)(8.15) = 0.082 \ \#/\text{ton}$$

$$\boxed{E_{111(d)_{F^-}} \underset{\text{TEXTILE}}{} = 0.082 \ \#/\text{ton produced}}$$

$$E_{111d_{F^-}} \underset{\text{WOOL}}{} = (1-.99)(.08) = 0.001$$

$$\boxed{E_{111(d)_{F^-}} \underset{\text{WOOL}}{} = 0.001 \ \#/\text{ton produced}}$$

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Source FIBERGLASS

Summary (Fluorides)

	E_U	E_N	E_S	E_{111d}
TEXTILE	8.15	0.02	8.15	0.082
WOOL	0.08	0.02	0.08	0.001

Summaries can be found on the following pages: 5, 8, 9, 11, 14

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Source Frit Mfg

Ref ⟨234⟩ p 3-231

Fluorospar Use in 1968 = 7800 tons

Ref ⟨234⟩ p 3-232,3 indicates the relationship (typical) between fluorospar & frit manufactured

$$\frac{215\ \#F/\text{ton CaF}_2}{3.15\ \#F/\text{ton frit}} = 68.25\ \frac{\text{ton frit}}{\text{ton CaF}_2}$$

$$7800\ \text{tons CaF}_2 \times 68.25\ \frac{\text{ton frit}}{\text{ton CaF}_2} = 0.532 \times 10^6\ \text{tons frit}$$

‖
1968 Production

No direct information could be found regarding fractional utilization, K. However, we can estimate it from that of similar industries. Ref ⟨144⟩ p 48 indicates a K for "stone, clay & glass" = 80% for the period 1965 - 1973. We will assume this value.

$$\boxed{K = 0.80}$$

Again, no specific information could be located regarding growth rate. We will, therefore, assume the growth to be similar to that experienced by similar industries.

Brick & Related Clay Products — 2.7% s
Ceramic Clay — 4.2% s
Castable Refractories - 4.3% s

See Specific Calculation Sheets for the development of these

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Source Frit

growth rates

$$P_{C_{AVG}} = \frac{2.7+4.2+4.3}{3} = 3.7$$

$$\boxed{P_C = 0.037} \text{ simple}$$

$$A = \frac{(0.532\times10^6)(1+[7][.037])}{.8} = 0.837\times10^6$$

$$\boxed{A = 0.837\times10^6 \text{ tons}}$$

Ref ㊲ p34 indicates that the IRS allowable depreciation for "other stone & clay products" which includes "ceramic insulating materials" is 15 years. We will assume this to be representive. So, using twice the allowable,

$$P_B = \frac{1}{(2)(15)} = 0.033$$

$$\boxed{P_B = 0.033} \text{ simple}$$

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Source Frit Mfg

Ref (75) p 8.12-2 TAB 8.12-1

Uncontrolled Particulate Emission = 16 #/TON MAT'L PROCESSED

Ref (234) p 3-233 indicates that 890 LBS of frit are Mfg from 990 LBS of feedstock

$$E_{up} = 16 \frac{\#}{\text{TON INPUT}} \times \frac{990 \text{ TON INPUT}}{890 \text{ TON OUTPUT}} = 17.8$$

$$\boxed{E_{up} = 17.8 \ \#/\text{TON FRIT}}$$

Ref (75) p 8.12-2 TAB 8.12-1 indicates that high ΔP venturi scrubbers can reduce particulates by 67%. Ref ㊻ p 788 indicates that a baghouse could also be used however, no η is stated. We feel that an efficiency of at least 90% could be attained with a properly designed unit.

$$E_{N_p} = 17.8(1-.9) = 1.78$$

$$\boxed{E_{N_p} = 1.78 \ \#/\text{TON FRIT}}$$

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Source Frit

From Ref (2-31) p 3-233 A typical furnace handling 1000# of RAW MAT'L/HR WAS SELECTED. This size would APPEAR TO BE TYPICAL also BASED on information IN Ref (46) p 783 which indicates sizes between 100 & 3000 LBS.

Since the geographical distribution of capacity is unknown, we will use the general PWR curve as developed from Ref (84) + (148)

$$PWR = 1000\ \#/HR$$

$$Allowable = 2.58\ \#/HR$$

$$ES_p = \frac{2.58(2000)}{890} = 5.80\ \#/\text{TON FRIT}$$

$$\boxed{ES_p = 5.80\ \#/\text{TON FRIT}}$$

Fluorides

Ref (75) p 8.12-2 TAB 8.12-1

$$E_{U_{F^-}} = f\left(5\ \#/\text{TON MAT'L PROCESSED}\right)$$

As with particulates,

$$5 \times 990/890 = \boxed{5.56\ \#/\text{TON FRIT} = E_{U_{F^-}}}$$

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Source Frit

High ΔP wet scrubbing will reduce fluorides by 94%

$$E_N = 5.56(1-.94) = 0.334$$

$$\boxed{\therefore E_{N_{F^-}} = 0.334 \ \#/\tfrac{\text{ton}}{\text{frit}}}$$

There are no applicable regulations for fluoride emissions

$$\therefore E_S = E_U$$

$$\boxed{E_{S_{F^-}} = 5.56 \ \#/\tfrac{\text{ton}}{\text{frit}}}$$

$E_{111(d)}$ A wet scrubber can be retrofit, in most cases, to an existing installation.

$$\therefore E_{111(d)} = E_N$$

$$\boxed{E_{\underset{F^-}{111(d)}} = 0.334 \ \#/\tfrac{\text{ton}}{\text{frit}}}$$

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Source FRIT

TRACE METALS

No mention of trace metal emissions was located. However, we can generate a factor from the mat'l flow balance sheet on p 3-232,233 of Ref ⑳④

From the 996 LBS of raw mat'l input (day)

(a) 300 # of borax ($Na_2B_4O_7$)
(b) 1 # of CoO
(c) 4 # of MnO
(d) 1 # of NiO

$$\frac{B_4}{Na_2 . B_4O_7} = \frac{4(10.8)}{2(11) + 4(10.8) + 7(16)} = \frac{43.2}{22 + 43.2 + 112} = .244$$

$$300(.244) = \underline{73.2}\ \#\ \text{boron}$$

$$\frac{Co}{CoO} = \frac{27}{27+16} = .628$$

$$(1)(.628) = \underline{.628\ \#\ \text{Cobalt}}$$

$$\frac{Mn}{MnO} = \frac{25}{25+16} = .610$$

$$(.610)(4) = \underline{2.44\ \#\ Mn}$$

$$\frac{Ni}{NiO} = \frac{28}{28+16} = .636 \qquad (.636)(1) = .636\ \#/Ni$$

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Source FRIT

$$\frac{73.2+.628+2.44+.636}{996} = \frac{76.904}{996} = .0772$$

If we assume that the particulate emission contains this % of trace metals, then

$$E_{U_{TM}} = 17.8(.0772) = 1.374\ \text{\#}/\tfrac{\text{TON}}{\text{FRIT}}$$

$$\boxed{E_{U_{TM}} = 1.374\ \text{\#}/\tfrac{\text{TON}}{\text{FRIT}}}$$

If we assume that the baghouse efficiency applies equally to TRACE METALS, then

$$E_{N_{TM}} = 1.374(1-.94) = 0.082$$

$$\boxed{E_{N_{TM}} = 0.082\ \text{\#}/\tfrac{\text{TON}}{\text{FRIT}}}$$

There are no regs for trace metals. ∴ $E_S = E_U$

$$\boxed{E_{S_{TM}} = 1.374\ \text{\#}/\tfrac{\text{TON}}{\text{FRIT}}}$$

If we assume that the efficiency of a wet scrubber for particulates

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Source FRIT

can remove TM's with equal efficiency, then

$$\boxed{E_{11(e)\,TM} = 0.082 \ \#/\text{ton}_{\text{FRIT}}}$$

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Source GLASS Mfg.

Ref ⑯ p 1-1 THERE ARE NEARLY 700 different compositions of glass.

p 1-2 Soda-lime glasses acount for 90% of the glass tonnage.

The mfg of opal glass is the major glass industry source of fluoride emission (REF ⑯ p 2-18)

We will, therefore, consider for this study

① Soda-lime glass
② Opal glass

Soda-Lime Glass

Ref ⑯ p 1-3 states that

1967 Production = 25×10^6 tons

Soda-limeglass = $(0.9)(25 \times 10^6) = 22.5 \times 10^6$ tons

Ref ⑯ P 1-5 TAB 1-5 shows an overall growth in the industry of 2.8% (simple)

$$\boxed{P_c = 0.028} \text{ simple}$$

$$\text{1975 Production S/L Glass} = (22.5 \times 10^6)\left[1+(8)(0.028)\right] = 27.54 \times 10^6$$

Ref (144) p 48 TAB 1 indicates a K for "Stone, Clay & Glass" to be 0.80 based on the Avg between 1965 and 1973

$$\boxed{K = 0.80}$$

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Source Glass Mfg

$$A = \frac{2754 \times 10^6}{0.80} = 34.43 \times 10^6$$

$$\boxed{A_{\text{SODA LIME GLASS}} = 34.43 \times 10^6 \text{ tons}}$$

Since no specific ref. could be found for P_B we will assume twice the IRS allowable depreciation for a similar industry - "other stone & clay products". Ref (37) p 34 gives the allowable as 15 yrs.

$$P_B = \frac{1}{(2)(15)} = 0.033$$

$$\boxed{P_B = 0.033}$$ simple

Opal Glass

Ref (234) p 3-219 TAB 3-73 indicates that in 1968, 34,500 tons of CaF_2 were used to make opal glass. Same Ref, p 3-218 shows that 4950 LB/HR of glass are produced from (among other constituents) 560 LB/HR CaF_2

$$\text{1968 Production of Opal Glass} = (34{,}500)\left(\frac{4950}{560}\right) = 0.305 \times 10^6 \text{ Tons}$$

Since no specific info could be located regarding K, P_C & P_B for opal glass mfg, we will assume them to be the same as for soda-lime glass

$$\boxed{K = 0.80}$$

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Source Glass Mfg.

$$\boxed{P_C = 0.028}$$ simple

$$\boxed{P_B = 0.033}$$ simple

$$A_{\substack{\text{OPAL}\\\text{GLASS}}} = \left(0.305\times10^6\right)\left[1+(7)(.028)\right] \div 0.80 = 0.456\times10^6$$

$$\boxed{A_{\substack{\text{OPAL}\\\text{GLASS}}} = 0.456\times10^6 \text{ tons}}$$

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Source Glass Mfg

SODA-LIME GLASS

Ref ⑮ p 8.13-1 TAB 8.13-1

$$\boxed{E_{UP_{\text{SODA LIME}}} = 2 \text{ LB/TON GLASS}}$$

The application of control devices in this industry is just developing (Ref ⑯ p 3-1). P 3-4 (same ref) NO [illegible], a 99%+ efficiency can be attained with fabric filters. Assuming 99%

$$E_{NP} = (1-.99)(2) = 0.02$$

$$\boxed{E_{NP_{\text{SODA LIME}}} = 0.02 \text{ LB/TON GLASS}}$$

Ref ⑯ p1-3 states that in 1967, [illegible] establishment shipped 68,000 tons of glass/YR

Assuming 330 days of operation @ 24 HRS/DAY

$$\frac{68{,}000(2000)}{(330)(24)} = 17{,}172 \text{ LB/HR production}$$

If we assume a feed/product ratio as mentioned on p3-218 of Ref ㉓④ FACTORS" & A K=0.80

$$PWR = \frac{(17172)(5480-90)}{(0.80)(4950)} = 23{,}373 \text{ LB/HR}$$

Since we do not know the geographical distribution of the 369 (Ref ⑯ p1-3)

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Source Glass Mfg

establishments, we will use the gen'l PWR curve generated from Refs (89) & (148)

Allowable = 20.3 LB/HR

$$\text{Production Rate} = \frac{17172}{(.8)(2000)} = 10.73 \text{ TPH}$$

$$E_{SP_{\text{SODA LIME}}} = 20.3/10.73 = 1.89 \ \text{LB/TON GLASS}$$

$$\boxed{E_{SP_{\text{SODA LIME}}} = 1.89 \ \text{LB/TON GLASS}}$$

Ref (75) p 8.13-1 TAB 8.13-1 gives a fluoride emission factor of 4 x %F LB/ton. In gen'l F⁻ emissions from soda-lime glass mfg are small.

Ref (16) p 2-10 indicates an effluent fluorine content of 1.9 - 2.2 ppm

We will assume this to be negligible

The same ref, page shows NO_x emissions of 340 (flint glass) + 640 (amber glass) ppmv. We must convert those values to LB/HR using other data found on p 2-10 of Ref (16)

$$\frac{\left(.029 \frac{\text{gr.}}{\text{SCF}}\right)(.60)}{\left(7000 \frac{\text{gr.}}{\text{LB}}\right)(2.1)} \ (\text{INVERT}) = \text{SCFM} = 84[illegible]$$

$$\frac{\left(340\times10^{-6} \frac{\text{FT}^3 NO_x}{\text{FT}^3 \text{gas}}\right)\left(8448 \frac{\text{FT}^3 \text{gas}}{\text{MIN}}\right)\left(60 \frac{\text{MIN}}{\text{HR}}\right)\left(46 \frac{\# NO_x}{\text{MOLE } NO_x}\right)}{387 \frac{\text{FT}^3 NO_x}{\text{MOLE } NO_x}} = 20.48 \frac{\text{LB } NO_x}{\text{HR}}$$

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Source Glass Mfg

If we assume that our typical plant size is applicable (no mention of production rate was given), 17,172 $\frac{LB}{HR}$ ≡ 8.568 TPH

$$Eu_{\underset{SODALIME}{NO_x}} = \frac{20.48 \frac{LB}{HR}}{8.568 \frac{TON}{HR}} = 2.39 \text{ LB/ton for flint glass furnace}$$

Now for amber glass furnace

$$\frac{(7000)(5.4)}{(.041)(60)} = SCFM = 15,366$$

$$(640 \times 10^{-6})(15366)(60)(46) / 387 = 70.14 \frac{LB}{HR}$$

$$Eu_{\underset{\underset{LIME}{SODA}}{NO_x}} = \frac{70.14}{8.568} = 8.186 \text{ LB/ton for amber glass furnace}$$

We will assume the avg

$$Eu_{NO_x} = \frac{2.39 + 8.186}{2} = 5.29$$

$$\boxed{Eu_{\underset{SODA\text{-}LIME}{NO_x}} = 5.29 \text{ LB/ton GLASS}}$$

Ref (342) p 9-1 states that control efforts for kilns, furnaces etc. are just beginning & anticipated levels of NO_x reduction have not yet been formulated. As we have done in the past, we will set $E_N = 0.0$ to det'n the maximum hypothetical impact that could exist under 100% control. This will aid in a prioritization for control techniques R&D efforts.

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Source Glass Mfg

$$\boxed{E_{N_{NO_x}\ \text{sodalime}} = 0.0\ \text{LB/Ton glass}}$$

The avg NO$_x$ control level for the U.S is 0.218 LB/10^6 BTU for gas fired units < 250x10^6 BTU/HR (Avg of info from Ref ㉔ + (148) - See "EMISSION FACTORS - BOILERS"). For oil the value is 0.3 LB/10^6 BTU

Ref ㊻ p 772-774 gives heat input req'ts for N.G. fired regenerative furnace.

Using a value of 6 FT^2/ton glass per day

& 8.568x24 tons of glass/day, 16 hrs/day

$$(6)(16)(8.568) = 823\ ft^2 \Rightarrow 7500\ ft^3/\text{ton glass of N.G.}$$

From Fig 591 p 774 Ref ㊻

@ 1050 BTU/FT^3 Ref (75) p 1.4-1

$$\left(7500\ \frac{FT^3}{\text{ton glass}}\right)\left(1050\ \frac{BTU}{FT^3}\right) = 7.875 \times 10^6\ \frac{BTU}{\text{ton glass}}$$

Assuming a fuel use of 50/50 oil/gas

$$\left(7.875\times10^6\right)\left(\frac{0.218+.3}{2}\right)10^{-6} = 2.04\ \text{LB/ton glass} = E_S$$

$$\boxed{E_{S_{NO_x}\ \text{soda-lime}} = 2.04\ \text{LB/ton glass}}$$

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Source Glass Mfg

SOx A ~~a~~ analysis, similar to NOx can be conducted Using the same Ref's & pages AS NOx

$$\frac{(10^{-6})(250+17)(8448)(60)(64)}{387} = 22.38 \frac{\text{LB SO}_x}{\text{HR}}$$

ASSUME ALL SO_2

$$E_{U_{SO_x}}{}_{\text{soda lime}} = \frac{22.38}{8.568} = 2.61 \text{ LB/ton glass}$$ (flint glass)

$$\frac{(315+15)(10^{-6})(15366)(60)(64)}{(387)(8.568)} = 5.872 \text{ LB/ton glass}$$ (amber glass)

We will assume the avg

$$\frac{5.872+2.61}{2} = 4.24$$

$$\boxed{E_{U_{SO_x}}{}_{\text{soda-lime}} = 4.24 \text{ LB/ton glass}}$$

For the same reason as for NOx

$$\boxed{E_{N_{SO_x}}{}_{\text{SODA-LIME}} = 0.0}$$

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Source Glass Mfg

The avg SO_x content level for oil in the U.S. is 1.589 LB/10^6 BTU

There are no specific regs for gas, however, one would not expect a state to permit more than that for oil.

$$(7.875 \times 10^6)(1.589)(10^{-6}) = 12.51 \text{ LB/ton}$$

Since this is > than E_U, $E_S = E_U$

$$\boxed{E_{S_{SO_x \atop \text{SODA-LIME}}} = 4.24 \text{ LB/ton glass}}$$

OPAL GLASS

It will be assumed that particulate emissions from an opal glass furnace are equal to that from a soda-lime glass furnace plus the particulate fluoride that is emitted.

Ref ②⑨ p 3-218 states fluoride emissions of $\frac{0.6(2000)}{4950} = 0.242$ L

$$E_{U_{P \atop \text{opal glass}}} = 2 + .24 = 2.24 \text{ LB/ton}$$

$$\boxed{E_{U_{P \atop \text{OPAL glass}}} = 2.24 \text{ LB/ton glass}} \longleftarrow \text{includes solid fluorides}$$

As was the case for particulates from soda-lime glass, $\eta = 99\%^+$ using filters. Assuming 99%,

$$E_N = (1 - .99)(2.24) = 0.0224$$

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Source Glass Mfg

$$\boxed{E_{N_P \text{ opal glass}} = 0.0224 \text{ LB/ton glass}}$$

Ref (234) p3-217 states that there are 5 opal glass plants each having a capacity of between 60 & 70 TPD Assuming the avg of 65 & 16 hrs/day

$$\frac{(65)(2000)}{16} = 8125 \text{ LB/HR output capacity}$$

Using a feed/product rate as per p1 of these calc's,

$$PWR = \frac{(8125)(5480-90)}{4950} = 8847 \text{ LB/HR}$$

Using the generalized PWR curve developed from Ref's (84) & (148) The allowable is 10.6 LB/HR

$$E_S = \frac{(10.6)(2000)}{8125} = 2.61 \text{ LB/ton glass}$$

Since this is > than E_U, $E_S = E_U$

$$\boxed{E_{S_P \text{ opal glass}} = 2.24 \text{ LB/ton glass}}$$

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Source Glass Mfg

Opal Glass

Fluorides

Ref ㉓④ p 3-218: gives the uncontrolled fluoride emission factor of

$$\frac{(54.0+0.6)(2000)}{4950} = 22.06 \ \text{LB/ton glass}$$

54.0 (gaseous)
0.6 (solid)

$$\boxed{E_{U_{F^-}\,\text{opal glass}} = 22.1 \ \text{LB/ton glass}}$$

The only collection device that would reduce the gaseous HF is a wet scrubber (Ref (234) p 3-220) with an 80% η (same page)

$$E_N = (1-.8)(22.1) = 4.42 \ \text{LB/ton glass}$$

$$\boxed{E_{N_{F^-}\,\text{opal glass}} = 4.42 \ \text{LB/ton glass}}$$

Since there are no regs governing HF emissions & since particulate control would cause a "defacto" control of solid fluorides

$$\boxed{E_{S_{F^-}\,\text{opal glass}} = 22.1 \ \text{LB/ton glass}}$$

Since a wet scrubber could, in most cases, be retrofit to an existing installation, we assume $E_{111d} = E_N$

$$\boxed{E_{111d_{F^-}\,\text{OPAL GLASS}} = 4.42 \ \text{LB/ton glass}}$$

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Source Glass Mfg

We will assume that emissions of NO_x & SO_x will be the same as for soda-lime glass mfg since the furnaces and temperatures are similar.

NO_x

$$\boxed{E_{U_{NO_x}} = 5.29 \ \text{LB/TON GLASS}}$$
opal glass

$$\boxed{E_{N_{NO_x}} = 0.0}$$
opal glass

$$\boxed{E_{S_{NO_x}} = 2.04 \ \text{LB/TON GLASS}}$$
opal glass

SO_x

$$\boxed{E_{U_{SO_x}} = 4.24 \ \text{LB/TON glass}}$$
opal glass

$$\boxed{E_{N_{SO_x}} = 0.0}$$
opal glass

$$\boxed{E_{S_{SO_x}} = 4.24 \ \text{LB/TON GLASS}}$$
opal glass

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Source GLASS MFG

SUMMARY:

	SODA-LIME GLASS			OPAL GLASS			
	E_U	E_N	E_S	E_U	E_N	E_S	E_{IIId}
Pt	2.0	0.02	1.89	2.24*	.0224*	2.24	—
F^-	—	—	—	22.1	4.42	22.1	4.42
NO_x	5.29	0.0	2.04	5.29	0.0	2.04	—
SO_x	4.24	0.0	4.24	4.24	0.0	4.24	—

* INCLUDES solid FLUORIDES

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 11/25/74

Source Gypsum

REF (144) p 5-38

PRODUCTION 1973 $= 12.592 \times 10^6$ TONS

FROM REF (95) p 214.3020 6/69

THE GROWTH TREND FOR CALCINED gypsum APPEARS TO BE RELATIVELY FLAT. THE MANY UPS & DOWNS ARE PROBABLY DUE TO TRENDS IN THE HOUSING INDUSTRY — THE MAJOR USER OF THE PRODUCT.

THE "AVG" GROWTH WILL BE DET'D FROM DATA (REF 95) BETWEEN 1950 & 1968. THE GROWTH TREND OVER THIS LONG PERIOD IS PROBABLY MORE REPRESENTATIVE THAN THAT DET'D FROM TWO CONSECUTIVE YEARS

Assume simple growth:

1950 $= 7.4 \times 10^6$ TONS
1968 $= 8.7 \times 10^6$ TONS

$$\left(\frac{8.7-7.4}{18}\right)(10^6) = .072 \times 10^6 \text{ TPY}$$

$$1975 \text{ Production} = 12.592 \times 10^6 + 2(.072 \times 10^6)$$
$$= 12.736 \times 10^6 \text{ TONS}$$

No direct information could be found relative to FRACTIONAL UTILIZATION RATE

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Source Gypsum

From Ref (144) p 18, K for "stone, clay, and glass" = 80% for the period '65 → '73.
We will assume this value for gypsum

$$\boxed{K = 0.80}$$

$$A = \frac{12.736 \times 10^6}{.80} = 15.92 \times 10^6$$

$$\boxed{A = 15.92 \times 10^6 \text{ tons}}$$

$$P_c = \frac{0.072}{12.74} = 0.0057$$

$$\boxed{P_c = 0.0057} \text{ simple}$$

Ref (37) p 34

IRS allowable depreciation for "cement" } = 20 yrs

IRS allowable depreciation for "other stone and clay products" } = 15 yrs

$$\text{Assume } P_B = \frac{1}{2(\text{AVG})} = \frac{1}{2(17)} = \boxed{.0294 = P_B} \text{ simple}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 11/25/74

Source Gypsum

PARTICULATES

REF (75) TAB 8.14-1

RAW MAT'L DRYER = 40 #/TON
PRIMARY GRINDER = 1 "
CALCINER = 90 "
CONVEYING = .7 "

131.7 #/TON

$$\boxed{E_U = 131.7 \text{ \#/TON MAT'L PROCESSED}}$$

REF (75) TAB 8.14-1 INDICATES $E_N = 0.2 + .001 + .1 + .001$
$= .302$ #/TON
USING A FABRIC FILTER

$$\therefore \boxed{E_N = 0.302 \text{ \#/TON MAT'L PROCESSED}}$$

REF (152) 79 PLANTS IN 1971

$$\text{CAPACITY IN 1971} = \frac{(12.592 \times 10^6) - 2(.072 \times 10^6)}{0.80} = 15.56 \times 10^6 \text{ TONS}$$

$$\text{TYPICAL PLANT SIZE} = \frac{15.56 \times 10^6 \text{ TONS}}{(79)(8760)} = 22.48 \text{ TONS/HR}$$

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Source Gypsum

22.48 x 2000 = 44,960 pph

REF ⑮② p 3 names 10 States representing a cross - section of the AREAS mfg. gypsum

CAL.
Fla.
Georg.
IND.
IOWA

Mich
N.J.
N.Y.
Okla.
TEX.

From REF (84) + (148) + (156)

Fla - 23.0 pph
Georg - 33.0 pph
IND - 33.0 pph
Iowa - 33.0 pph

Mich - 33.0 pph
N.J. - 30.0 pph
N.Y. - 29.5 pph
Okla - 33.0
TEX - 62.0

Calif - 30.2

Assuming equal distribution:

ALLOWABLE = 33.97 #/HR

$$E_S = \frac{33.97}{22.48} = 1.51 \text{ \#/TON}$$

$$\boxed{E_{S_{PART}} = 1.51 \text{ \#/TON}}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 12/20/74

Source Lime

REF (215) p728ff 1972 PRODUCTION = 20.33 x10^6 TONS TOTAL

REF ㊾ p244 TAB 12-1 gives breakdown between ROTARY KILNS & VERTICAL KILNS for 1968

$$\text{ROTARY} = {}^{16.2}/_{18} = 90\%$$

$$\text{VERTICAL} = {}^{1.8}/_{18} = 10\%$$

REF ㊿ p1 gives anticipated growth rates of 5.1%, 4.8% & 5.1%. We will assume an average = 5% compound.

$$\boxed{P_c = 0.05} \quad \text{compound}$$

Ref ㊷ p122 TAB 15

This table gives the relationship between added capacity & increased production. From this we can determine K.

$$\underset{1972-1975}{\Delta\text{CAPACITY}} = 128+157+185+213 = 683 \times 10^3 \text{ tons}$$

$$\underset{1972-1975}{\Delta\text{Production}} = 1150 - 536 = 614 \times 10^3 \text{ tons}$$

$$K = \frac{614}{683} = 0.90$$

$$\boxed{K = 0.90}$$

$$A = (20.33 \times 10^6)(1.05)^3 / 0.90 = 26.15 \times 10^6 \text{ tons}$$

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Computation Sheet For Industrial Factors

Calculations Done By Hoppe Date 12/20/74

Source Lime

$$\boxed{A = 26.15 \times 10^6 \text{ tons}}$$

Ref ㊲ p 30 "Mining" - IRS Allowable - 10yrs
Ref ㊲ p 33 "Manufacture Of Chemicals and Allied Products .....organic and inorganic chemicals - 11yrs

Assume 2x10yrs to be representative

$$P_B = \frac{100\%}{20\text{yrs}} = 5\%$$

$$\boxed{P_B = 0.05}$$ simple

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Calculations Done By Hower Date 12/20/74

Source Lime

Ref ㊾ p244 TAB 12-1

$$E U_{p_{\text{ROTARY}}} = 180 \ {}^{\#}/_{\substack{\text{TON} \\ \text{LIME}}}$$

$$E U_{p_{\text{VERTICAL}}} = 7 \ {}^{\#}/_{\substack{\text{TON} \\ \text{LIME}}}$$

We previously calculated

(a) 90% processed in rotary kilns
(b) 10% processed in vertical kilns

Synthesizing

$$E U_p' = 180(.9) + 7(.1) = 162 + .7 = 162.7$$

$$E U_p' = 162.7 \ {}^{\text{LB}}/_{\substack{\text{TON} \\ \text{LIME}}} \quad *$$

Also

24 $^{\text{LB}}/_{\substack{\text{TON} \\ \text{ROCK CRUSHED}}}$ from the crushing & screening operation

Ref ㊿ p 4 indicates that 28×10^6 tons of rock were crushed to make 19×10^6 tons of lime

$$\left(24 \ {}^{\text{LB}}/_{\substack{\text{TON} \\ \text{CRUSHED}}}\right) \times \left(\frac{28 \times 10^6 \text{ TON CRUSHED}}{19 \times 10^6 \text{ TON LIME}}\right) = 35.4 \ {}^{\#}/_{\substack{\text{TON} \\ \text{LIME}}} \quad *$$

Also, 5 $^{\text{LB}}/_{\substack{\text{TON} \\ \text{LIME}}}$ for mat'ls handling

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Calculations Done By Hopper Date 12/19/74

Source Lime

$$\Sigma E_U = 162.7 + 35.4 + 5 = 203$$

$$\boxed{E_{U_p} = 203 \text{ LB/TON LIME}}$$

Ref ㊾ p 249 & Ref (192) p 195ff indicate that bag filters can be employed in all areas to control particulate emissions by 99.99%. We feel that 99.9% would represent a more realistic value.

$$E_N = (1 - .999)(203) = 0.203$$

$$\boxed{E_{N_p} = 0.203 \text{ LB/TON LIME}}$$

E_S

Ref (215) p 728ff indicates 186 lime plants in 1972

Ref ㊾ p 253 indicates the typical kiln capacity is about 200 tons/day

Assuming 330 days/yr operation @ K = 0.90

$$\text{Yearly Production from 1 kiln} = \left(200 \frac{\text{TONS}}{\text{DAY}}\right)\left(330 \frac{\text{days}}{\text{YR}}\right)(0.90) = 0.0594 \times 10^6 \frac{\text{TONS}}{\text{YR} \cdot \text{KILN}}$$

$$1972 \text{ Production} = 20.33 \times 10^6 \text{ TONS/YR}$$

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Calculations Done By Hopper Date 12/20/74

Source Lime

$\# \text{kilns} = \frac{20.33}{.0594} = 342$ or $342/186 = 1.8$ per plant

So,

$$\frac{200 \frac{\text{tons}}{\text{day}}}{24 \frac{\text{hrs}}{\text{day}}} = 8.33 \text{ TPH} = 16{,}666 \text{ LB/HR} \quad \text{OUTPUT CAPACITY}$$

The calcining of limestone proceeds as follows

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$\frac{\text{INPUT}}{\text{OUTPUT}} = \frac{20+12+48}{20+16} = \frac{80}{36} = 2.222 = \text{FEED/PRODUCT}$$

$$\text{PWR} = 16{,}666 \times 2.222 \approx 37{,}000 \text{ LB/HR}$$

From Ref ⑮ (215) we get the following breakdown in State production figures for quicklime

(20%) Ohio — 3.488×10^6
(15.3%) MO — 2.7×10^6 (Estimate)
(11.4%) Penn — 2.015×10^6
(5.83%) Tex — 1.032×10^6
(9.10%) Mich — 1.610×10^6
(5.0%) Ill - $\underline{0.890 \times 10^6}$
11.74

$$\frac{11.74}{17.687} = 66\%$$

↑ Ref (215) p 728

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/20/74

Source Lime

From Ref (84), (148) & Hagen'l PWR curve

Ohio — 29.0

MO. — 29.0

Penn — $A = .76\left[(F)(W)\right]^{.42} = (.76)\left[(200)(18.5)\right]^{.42} = .76(32.52) = \boxed{24 \ \text{LB/HR}}$

Tex — 55.0

Mich - 25.4 ← A SPECIFIC REG EXISTS AS A function of 98.5% effic.

$\text{SO } E_{s_{mich}} = (1-.985)(203) = 3.05$

$3.05\ \#/\text{TON} \times 8.33\ \frac{\text{TON}}{\text{HR}} = 25.4$

Ill — 12.0

All Others — 27.7

$$E_{s_p} = f\Big[(29.0)(\overset{\checkmark}{.20}) + (29.0)(\overset{\checkmark}{.153}) + (55)(\overset{\checkmark}{.058}) + (25.4)(\overset{\checkmark}{.091}) + (12.0)(.05) + (24.0)(.114) + (27.7)(.334)\Big]$$

$$= f\left[\overset{\checkmark}{5.8} + \overset{\checkmark}{4.44} + \overset{\checkmark}{3.19} + \overset{\checkmark}{2.31} + \overset{\checkmark}{.60} + 2.74 + 9.25\right]$$

$$= 28.33\ \text{LB/HR}$$

$$E_{sp} = \frac{28.33\ \text{LB/HR}}{8.33\ \text{TONS/HR}} = 3.40$$

$$E_{sp} = 3.40\ \text{LB/TON LIME}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/20/74

Source Lime

SO_x Since no emission factors could be located, it is necessary to develop one.

From Ref (192) p200, the % fuel use breakdown is

60%	COAL
28%	NAT. GAS
6%	COAL+GAS
6%	#6 OIL (RESIDUAL)

Heat input req'ts Ref ㊷ p126

$$\text{for High Calcium Quicklime} \quad (1.5+2.8)\times10^6\ \text{BTU}/\tfrac{\text{TON}}{\text{LIME}} = 4.3\times10^6$$

$$\text{for Dolomitic Quicklime} \quad (1.25+2.6)\times10^6\ \text{BTU}/\tfrac{\text{TON}}{\text{LIME}} = 3.85\times10^6$$

Assume a linear AVG $= 4.1\times10^6$ BTU/TON LIME

$4.1 \times \frac{200}{24} = 34$ MM BTU/HR

From Ref (75) p 1.1-3 TAB 1.1-2

$$SO_2 \text{ emissions from bituminous coal} = 38S \ (<10\text{MM BTU/HR}) \ \#/\text{TON COAL BURNED}$$

From Ref (75) p 1.3-2 TAB 1.3-1

$$SO_x \text{ from RES. OIL} = (152+2)S \ \#/1000\text{GAL}$$

$$SO_x \text{ from NAT GAS} = 0.6\ \text{LB}/10^6\ \text{FT}^3$$

If fuel was 100% COAL

$$E'U_{SO_2} = \frac{\left(4.1\times10^6 \frac{\text{BTU}}{\text{TON LIME}}\right)\left(38S\right)\frac{\#}{\text{TON COAL}}}{\text{BTU/TON COAL}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoppe Date 12/20/74

Source Lime

FROM Ref ㉒ p4-2 TAB 4-1

$HV_{COAL} = 26.2 \times 10^6 \frac{BTU}{TON\ COAL}$

$\% S_{COAL} = 2\%$

So,

$$E'_{SO_x\ COAL} = \frac{(4.1 \times 10^6)(38)(2)}{26.2 \times 10^6} = 11.9\ LB/TON\ LIME \quad *$$

If fuel is 100% GAS

$$E'_{SO_2\ gas} = \frac{(4.1 \times 10^6)(.6 \times 10^{-3})}{\underset{\uparrow \text{Ref (75) p1.4-1}}{1050}} = 2.34 \times 10^{-3}\ LB/TON\ LIME \quad *$$

If fuel is 100% Res. oil.

$\% S = 1.5\%$ Ref ㉒ p4-4 TAB 4-2

$HV = 6384 \times 10^6\ BTU/10^3 BBL$

$$\frac{6384 \times 10^6}{1000 BBL} \times \frac{1\ BBL}{42\ gal} = \frac{152 \times 10^6\ BTU}{1000 gal}$$

$$E_{SO_2\ R.O.} = \frac{(4.1 \times 10^6)(154)(1.5)}{152 \times 10^6} = 6.23\ LB/TON\ LIME \quad *$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/20/74

Source Lime

Synthesing

$$E_{U_{SO_2}} = (11.9)(.6+.03) + (\overset{x10^{-3}}{2.34})(.28+.03) + (6.23)(.06)$$

$$= 7.497 + .000725 + .3738 = 7.87\ \#/\text{ton lime}$$

However, Ref ⑺⑸

p 8.6-3 TAB 8.6-1 states that the emission factor for a cement kiln for SO_2 is 6.8 S #/ton (coal). This reduction from 38 S is due to the alkaline dusts which are also present in lime kilns. This corresponds to a % reduction of

$$\frac{38-6.8}{38} = 82\%$$

If we assume a similar reduction, then

$$E_U = (1-.82)(7.87) = 1.417$$

$$\boxed{E_{U_{SO_2}} = 1.42\ \text{LB/TON LIME}}$$

The bag filter specified for the control of particulate will also control SO_2 due to the cake buildup on the bags of alkaline dusts.

Ref ⑺⑸ p8.6-3 indicates that an SO_2 removal efficiency $\approx 50\%$ could be expected @ the filter of a cement kiln. We will assume the same η.

$$E_{N_{SO_2}} = (1-.5)(1.42) = 0.71$$

$$\boxed{E_{N_{SO_2}} = 0.71\ \#/\text{ton lime}}$$

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Source Lime

$E_{S\ SO_2}$

$$\frac{1.42 \frac{\#SO_2}{\text{TON LIME}}}{4.1 \times 10^6 \frac{\text{BTU}}{\text{TON LIME}}} = 0.35 \ \#/10^6 \text{BTU}$$

From Ref (84) + (148)

This value is less than, or @ best, equal to the State reg's for SO_2 (Ohio, Mo., Mich, Penn, Ill, Texas)

$$\therefore E_{S_{SO_2}} = E_U$$

$$\boxed{E_{S_{SO_2}} = 1.42 \ \#/\text{TON LIME}}$$

NOx As was the case with SO_x, it is necessary to develop an NO_x emission factor

From Ref (75) p1.1-3 TAB 1.1-2

$$\text{NO}_x \text{ emissions from BIT COAL} = 6 \ \#/\text{TON COAL}$$

Ref (75) p1.3-2 TAB 1.3-1

$$\text{NOx}_{\text{Res. Oil}} = 60 \ \#/1000 \text{gal} \ (\text{AVG})$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/23/74

Source Lime

Ref ⑮ P

$$NO_{x\,\text{NAT GAS}} = 120\ \#/10^6\ \text{FT}^3$$

If fuel WAS 100% COAL

$$E'U_{NO_x} = \frac{\left(4.1\times10^6\ \frac{\text{BTU}}{\text{TON LIME}}\right)\left(6\ \frac{\#}{\text{TON COAL}}\right)}{26.2\times10^6\ \frac{\text{BTU}}{\text{TON COAL}}} = 0.939\ \#/\text{ton lime}\ \text{(COAL)}\quad *$$

If fuel was 100% gas

$$E'U_{NO_x} = \frac{(4.1\times10^6)(120)\times10^{-6}}{1050} = 0.469\ \#/\text{ton lime}\ \text{(gas)}\quad *$$

If fuel was 100% RES. OIL

$$E'U_{NO_x} = \frac{(4.1\times10^6)(60)}{152\times10^6} = 1.618\ \#/\text{ton lime}\ \text{(oil)}\quad *$$

Synthesizing,

$$EU_{NO_x} = (.63)(.939)+(.31)(.469)+(.06)(1.618)$$
$$= .592+.145+.097 = 0.834$$

$$\boxed{EU_{NO_x} = 0.834\ \#/\text{TON LIME}}$$

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Calculations Done By Hopper Date 12/23/74

Source Lime

Ref (242) p 9-1 indicates that no control methods have been demonstrated for NO_x emissions from industrial process combustion equipment. This Ref is dated 10/74 & is, ∴, very recent.

However, p 7-13, 7-16 indicates ~~that~~ by 1985, a reduction of ~50% should be achieved for residential heaters. Assuming the potential for a transfer of technology, we will use this value & present the results in the EU = 0.0 ~~etc~~ category.

$$E_{N_{NO_x}} = (1-.5)(.834) = 0.417$$

$$\boxed{E_{N_{NO_x}} = 0.417}$$

The NO_x regs for most States are the same

0.2 #/10⁶ BTU gas
0.3 " oil
0.7 " coal

Synthesizing

$$(.63)(.7) + (.31)(.2) + (.06)(.3) = .441 + .062 + .018 = .521 \ \#/10^6 BTU$$

$$\left(.521 \frac{\# NO_x}{10^6 BTU}\right)\left(4.1 \times 10^6 \frac{BTU}{TON\ LIME}\right) = 2.136 \ \#/\frac{ton}{lime}$$

Since this is $> E_{U_{NO_x}}$ $E_S = E_U$

$$\boxed{E_{S_{NO_x}} = 0.834 \ \#/\frac{ton}{lime}}$$

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 12/23/74

Source Lime

Summary

	E_U	E_N	E_S
PART	203	.203	3.40
NO_x	.834	0.417	.834
SO_x	1.42	.71	1.42

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 11/27/74

Source Mineral Wool

No direct values of production in TONS could be located. REF ⑮⑧ (MC72 P-32E-5) indicates production in terms of tons, square feet & board feet depending on the end use. They also quote the value ($MM) of the product. We will attempt to det'n TOTAL industry production in TONS using this value data assuming that the value is directly proportional to the weight.

In 1972, there were 331,300 tons of loose fiber valued @$37.2 x10⁶ dollars

Total value of the industry was $729.6 x10⁶

$$\frac{331,300}{37.2} = \frac{X}{729.6} \qquad X = 6.50 \times 10^{6} \text{ tons}$$

Since a majority of the info regarding production breakdowns for various products is not stated, no cross check can be made using product densities & footage produced.

A similar calculation can be made for the year 1972. Using the same reference

$$\frac{261,900}{19.2} = \frac{X}{425} \qquad X = 5.797 \times 10^{6} \text{ tons}$$

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Source Mineral Wool

Assume simple growth, since we have made such an assumption. This will minimize the potential compounding of errors.

$$\frac{(6.5-5.8)\times10^6}{5} = 0.14\times10^6 \text{ TONS/YR}$$

$$6.5+3(.14) = 6.92\times10^6 = 1975 \text{ Production}$$

$$P_c = \frac{0.14}{6.92} = 2.0\%$$

$$\boxed{P_c = .02} \text{ simple}$$

No specific ref was made as to functional utilization. From Ref (144) p 48, K for "stone, clay & glass" = 80% for the period '65-'73. Also, the avg value of K for chemicals during that period was 83%. We will assume a K = 82% for the mfg. of mineral wool.

$$\boxed{K = 0.82}$$

$$A = \frac{6.92\times10^6 \text{ tons}}{.82} = 8.439\times10^6$$

$$\boxed{A = 8.439\times10^6 \text{ tons}}$$

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Source Mineral Wool

P_B: REF ㊲ p34

IRS Allowable depreciation for "cement" = 20 yrs

IRS allowable depreciation for "other stone & clay products" = 15 yrs

Assume $P_B = \frac{1}{2(AVG)} = \frac{1}{2(17)} = .0294$

$$\boxed{P_B = .0294}$$

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Source MINERAL WOOL

PARTICULATES

REF (75) p 8.16-2 TAB 8.16-1

UNCONTROLLED EMISSIONS:

22 #/TON FROM CUPOLA
17 #/TON FROM BLOWCHAMBER
4 #/TON FROM CURING OVEN
2 #/TON FROM COOLER

WE ASSUME THAT ALL MINERAL WOOL IS MADE IN CUPOLAS – NOT REVERBATORY FURNACES. REF (46) p 342 INDICATES THAT THIS IS A VALID JUDGEMENT.

The origin of the above emission factors was Ref (46). A check indicates agreement except for the blowchamber.

From Ref (46) p 345 TAB 100

$$E_{U_1} = \frac{(9.20)(2000)}{3525} = 5.22$$

$$E_{U_2} = \frac{(7.11)(2000)}{3625} = 3.92$$

$$E_{U_3} = \frac{(8.3)(2000)}{4120} = 4.03$$

$$4.39 = \text{AVG}$$

$$E_{U_{TOTAL}} = 22 + 4.4 + 4 + 2 = 32.4$$

$$\boxed{E_{U_p} = 32.4 \text{ \#/ton}}$$

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Source Mineral Wool

Ref ⑯ p 347 indicates control of cupola particulate emissions with a baghouse. Page 348 indicates an $\eta = 97\%$

$$E_{N_{CUPOLA}} = 22(1-.97) = 0.66\ \#/\text{ton} \qquad *$$

Ref ⑯ p349 indicates control of blowchamber particulate emissions with a centrifugal scrubber, followed by an ESP The overall $\eta = 68\%$

$$E_{N_{\substack{BL.\\CH.}}} = 44(1-.68) \approx 1.41$$

$$E_{N_{\substack{BL.\\CH.}}} = 1.41 \qquad *$$

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Source Mineral Wool

Ref ⑯ p 345 indicates $\eta = 81\%$ for particulates from the curing oven by employing a wet scrubber followed by an ESP.

$$E_{N_{\text{curing oven}}} = 4(1-.81) = 0.76 \ \#/\text{ton}$$

Assume the use of a wet scrubber with an $\eta = 60\%$ (transfer of technology from the blowchamber – Ref ⑮ p 8.16-2 $\frac{\text{TAB}}{8.16-1}$)

$$E_{N_{\text{cooler}}} = 2(1-.60) = 0.8 \ \#/\text{ton}$$

$$\Sigma E_N = 0.66 + 1.41 + .76 + .8 = 3.63 \ \#/\text{ton}$$

$$\boxed{E_{N_p} = 3.63 \ \#/\text{ton}}$$

Ref ⑯ p 344
① PWR for cupola $\approx$ 4200 #/HR = 2.1 TPH
② PWR for blowchamber $\approx$ 4000 #/HR = 2.0 TPH
③ PWR for curing oven $\approx$ 5000 #/HR = 2.5 TPH

From Ref (158) p2 MC72(P)-32-E-5, The following breakdown is det'd on the basis of # of employees in the industry in 1972.

Ohio = 3.4/14.3 = 23.8%
Indiana = 1.7/14.3 = 11.9%
New Jersey = 1.5/14.3 = 10.5%
Texas = .7/14.3 = 4.9%
Alab. = .2/14.3 = 1.4%
Ill. = .1/14.3 = 0.7%
All other = 46.8%

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Hopper Date 11/27/74

Source Mineral Wool

From ref (84), ㊽ & (156)

Typ. PWR ≈ 2.1 + 2.0 + 2.5/3 = 2.2 TON = 4400 #/HR

Ohio = 6.9 #/HR
Ind = 6.9 #/HR
N.J. = 28 #/HR
Tex = 6.7 #/HR
Ill = 3.9 #/HR
All other = 7.6 #/HR
Alab. = 5.9

$$E_s = f\left[(.238)(6.9) + (.119)(6.9) + (.105)(28) + (.049)(6.7) + (.014)(5.9) + (.007)(3.9) + (.468)(7.6)\right]$$

$$= 1.6422 + .8211 + 2.94 + .3283 + .0826 + .0273 + 3.5568$$

$$= 9.3983$$

$$E_s = 9.3983/2.2 = 4.272$$

$$\boxed{E_{s_p} = 4.27 \text{ \#/ton}}$$

Sulfur Oxides are also emitted from cupolas

$\boxed{E_{U_{SO_2}} = 0.02 \text{ \#/ton}}$ Ref (75) p 8.16-2 TAB 8.16-1

Assume $E_N = 0.0$ since no feasible control has been demonstrated. This would det'n the max hypothetical

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Calculations Done By HOOPER Date 11/27/74

Source Mineral Wool

$$\boxed{E_{N_{SO_2}} = 0.0}$$

There are no State control regs.

$$\therefore \quad E_S = E_U = 0.02$$

$$\boxed{E_{S_{SO_2}} = 0.02 \text{ \#/ton}}$$

CO

Ref ㊻ p 344 Tab 98 indicates CO emissions of 0.9% from cupolas (very limited data)
We will assume % by volume

$$E_U = \frac{(.009)\left(4550 \frac{\text{FT}^3}{\text{MIN}}\right)\left(28 \frac{\#}{\#\text{mole}}\right)\left(2000 \text{ \#/ton}\right)\left(60 \frac{\text{MIN}}{\text{HR}}\right)}{\left(359 \frac{\text{FT}^3}{\#\text{mole}}\right)\left(\frac{530}{460}\right)\left(3525 \text{ \#/hr}\right)} = 94.4 \text{ \#/ton}$$

$$\boxed{EU_{CO} = 94.4 \text{ \#/ton}}$$

Assume $E_N = 0.0$ since no feasible control has been demonstrated. This will result in the max hypothetical impact if controls were applied

$$\boxed{E_{N_{CO}} = 0.0}$$

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Computation Sheet For Emission Factors

Calculations Done By Hoaer Date 12/2/74

Source Mineral Wool

There are no State emission regulations

$$\therefore \quad Es_{CO} = Eu_{CO} = 94.4 \text{ \#/ton}$$

$$\boxed{Es_{CO} = 94.4 \text{ \#/ton}}$$

$\underline{NO_2}$

Ref ㊻ p 346 Tab 101 indicates NO_2 emissions from the curing oven equal to .6 & .15 #/HR for units with a PWR of 5180 #/HR & 3500 #/HR respectively

$$Eu'_{NO_2} = \frac{0.6(2000)}{5180} = 0.232 \text{ \#/ton}$$

$$E^2_{u_{NO_2}} = \frac{(0.15)(2000)}{3500} = 0.086 \text{ \#/ton}$$

$$\overline{} \quad .159 = \text{AVG}$$

Assuming the avg, $\boxed{Eu_{NO_2} = 0.16 \text{ \#/ton}}$

Ref (242) p 7-13, 7-16 indicates that by 1985, NO_x emissions from residential heating can be reduced by ~50%. We will assume a similar reduction & include the results in the EN=0.0 category.

$$E_N = (1-.5)(0.16) = 0.08 \qquad \boxed{E_N = 0.08 \text{ \#/ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/2/74

Source Mineral Wool

The emission of NO_2 would be from the combustion process. Since regs are written on a #/10^6 BTU basis, it is necessary to convert our results for comparison purposes.

Crudely,

$$\frac{Q_{AIR} + Q_{WOOL}}{\eta_{\text{HEAT TRANSFER}}} = Q_{\text{INPUT BY FUEL}}$$

From Ref ㊻ p 346 TAB 101

$$Q_{air} = \left(8000 \frac{FT^3}{MIN}\right)\left(60 \frac{min}{HR}\right)(.075)\#/FT^3 \left(\frac{530}{460}\right)\underset{\uparrow}{(.24)}\left(200 - \underset{\uparrow}{70}\right)$$

Ref (101) p 3-131 TAB 3-179

Assume

$$Q_{air} = 1.294 \times 10^6 \frac{BTU}{HR}$$

$$Q_{WOOL} = (5180)\underset{\uparrow}{(.157)}\left(\underset{\uparrow}{200} - \underset{\uparrow}{70}\right) = 0.106 \times 10^6 \frac{BTU}{HR}$$

Ref (101) p 3-133 TAB 3-200

Assume

$$Q_{INPUT} = \frac{(1.294 + .106)(10^6)}{\underset{\uparrow}{0.80}} = 1.75 \times 10^6 \, BTU/HR$$

Assume

$$\text{EMISSION} = \frac{0.6 \, \#/HR}{1.75 \times 10^6 \, BTU/HR} = 0.34 \, \#/10^6 \, BTU$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/2/74

Source Mineral Wool

$$Q_{air} = (4870)(60)(.075)\left(\frac{530}{460}\right)(.24)(270-70) = 1.212 \times 10^6 \text{ BTU/HR}$$

$$Q_{wool} = (3500)(.157)(270-70) = .1099 \times 10^6$$

$$1.322 \times 10^6$$

$$\text{Emission} = \frac{.15(.80)}{(1.322 \times 10^6)} = .0908 \text{ \#}/10^6 \text{BTU}$$

The Avg = 0.215 #/10^6 BTU

From Ref ㉞, the allowable for....

GAS = .2
OIL = .3
SOLID = .7
} #/10^6 BTU

For the cases evaluated here, we do not know the fuel type. Generally speaking, some ovens would use oil & others gas. Since a synthesized value would fall somewhere between .2 & .3, we will assume Es = Eu

$$\boxed{Es_{NO_2} = 0.16 \text{ \#/ton}}$$

Hydrocarbons

The following info is taken from Ref ㊻ p 342 ff

TABS 100, 101, 102

SOURCE	EMISSION*	SCFM	PWR
BLOWCHAMBER	.0036 %	11,100	3525
OVEN	1.90 #/HR	—	5180
oven	2.20 #/HR	—	3500
cooler	.0009 %	1850	3525

*Assumed to be HCHO

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By Homer Date 12/2/74

Source Mineral Wool

$$E_{U_{\substack{BL.\\CH\\HC}}} = \frac{(.000036)(11,100)(30)(2000)(60)(460)}{(359)(530)(3525)} = 0.987 \text{ \#/ton}$$ *

$$E_{U_{\substack{oven\\HC\\\#1}}} = \frac{(1.90)(2000)}{5180} = .734 \text{ \#/ton}$$

$$E_{U_{\substack{oven\\HC\\\#2}}} = \frac{(2.20)(2000)}{3500} = 1.257 \text{ \#/ton}$$

$$0.996 = \text{AVG}$$ *

$$E_{U_{cooler}} = \frac{(9\times10^{-6})(1850)(30)(2000)(60)(460)}{(359)(530)(3525)} = .041 \text{ \#/ton}$$

$$\Sigma = 0.987 + .996 + .041 = 2.02$$

$$\boxed{E_{U_{HC}} = 2.02 \text{ \#/ton}}$$

Control of oven emissions using cat. A/B ⇒

$$\eta = \frac{1.90 - .9}{1.90} = 53\%$$

Using direct flame A/B,

$$\eta = \frac{2.20 - .94}{2.20} = 57\%$$

No demonstrated control has been shown for the blowchamber or the cooler. So Assume that 57% control can also be achieved for those units using a direct-flame A/B

$$E_N = 2.02(1-.57) \qquad \boxed{E_{N_{HC}} = 0.869 \text{ \#/ton}}$$

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Computation Sheet For Emission Factors

Calculations Done By Hopper Date 12/2/74

Source Mineral Wool

There are no State regs

$$\therefore \quad E_S = E_U = 2.02$$

$$E_S = 2.02 \text{ \#/ton}$$

Summary

	E_U	E_N	E_S
Part	32.4	3.63	4.27
SO_2	.02	0.0	.02
NO_2	0.16	0.08	.16
CO	94.4	0.0	94.4
HC	2.02	.87	2.02

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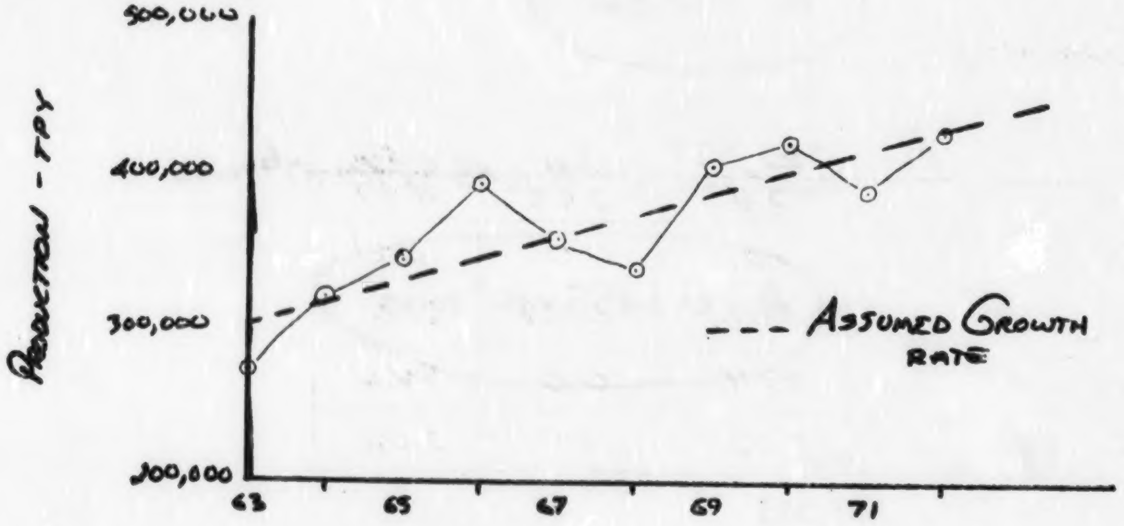
Computation Sheet For Industrial Factors

Calculations Done By HOPPER Date 11/26/74

Source PERLITE

REF ⓶⓵⓹ 1972 472,000 TONS of EXPANDED PERLITE PRODUCED

FROM REF ⓶⓵⓹ 1963, 65, 67, 69, 71, 72 WE obtained the following DATA



$$\frac{472{,}000 - 300{,}000}{9} = 19111 \text{ TPY}$$

1975 PRODUCTION = 472,000 + 3(19,111) = 529,333 TONS

NO SPECIFIC REF WAS MADE AS TO FRACTIONAL UTILIZATION FROM REF ⓵⓸⓸ p48 K for "STONE, clay & glass" = 8[illegible] % FOR THE PERIOD '65 - '73. Also, the AV'G VALUE of K for

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Computation Sheet For Industrial Factors

Calculations Done By Hopper Date 11/26/74

Source Perlite

Chemicals during that period was 83%.

We will ASSUME A $K = 82\%$ to be representa-
-tive of the perlite mfg. industry

$$\boxed{K = 0.82}$$

$$A = \frac{529,333}{.82} = 0.645528 \times 10^6 \text{ tons}$$

$$\boxed{A = 0.6455 \times 10^6 \text{ tons}}$$

$$P_C = \frac{1911}{529,333} = 0.036$$

$$\boxed{P_C = 0.036}$$ simple

P_B: Ref (57) p 3d; IRS allowable depreciation for "cement" } = 20yrs

IRS allowable depreciation for "other stone and clay products" } = 15yrs

Assume $P_B = \frac{1}{2(\text{AVG})} = \frac{1}{2(17)} = \boxed{.0294 = P_B}$

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Computation Sheet For Emission Factors

Calculations Done By Horace Date 11/25/74

Source PERLITE

REF (75)
p 8.17-1
TAB. 8.17-1

$E_{U_{part}} = 21$ #/ton of charge

FROM REF (75), SAME PAGE $\eta_{baghouse} = 96\%$

$$E_N = 21(1-.96) = 0.84$$

$E_{N_{part}} = 0.84$ #/TON OF CHARGE

Es:

REF ⑯ p 350

"SEVERAL PERLITE ORE DEPOSITS ARE IN CALIFORNIA AND OTHER DEPOSITS ARE IN SIX OF THE ROCKY MOUNTAIN STATES."

REF (215) IN 1972 THERE WERE 84 PLANTS IN 30 STATES
p 905 ff

#1	ILLINOIS	— UNPUBLISHED (ASSUME 35,000)
2	PENN.	29,790 TONS
3	CAL.	21,221 TONS
4	TEX.	21,210 TONS
5	FLA.	18,249 TONS
6	IND	16,331 TONS

⇒ 141,801/427,000 = 33%

REMAINING PRODUCTION IN 24 STATES

1972 DATA FROM REF 215 p905ff

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Computation Sheet For Emission Factors

Calculations Done By HOPPER Date 11/26/74

Source PERLITE

$$\frac{427{,}000}{.82} = \text{1972 CAPACITY} = 520{,}732 \text{ TONS}$$

$$\frac{520{,}732}{(84)(8760)} = 0.7077 \text{ TPH} = 1415 \text{ PPH}$$

ILL = 8.2%
PENN = 6.3%
CAL = 5.0%
TEX = 5.0%
FLA = 4.3%
IND = 3.8%
ALL OTHERS = 67.4%

FROM REF (84) & (148) & GEN'L PWR CURVE, ALLOWABLE EMISSIONS ARE....

ILL = 2.1
PENN = RELATES TO .04 GR/SCF; ASSUME AS PART OF GEN'L PWR
CAL = 3.42 (REF 156)
TEX = 2.2
FLA = 2.75
IND = 3.20
OTHERS = 3.25

$$E_S = f(.082)(2.1) + (.05)(3.2) + (.05)(2.2) + (.043)(2.75) + (.038)(3.20) + (737)(3.25) =$$

$$.1722 + .16 + .11 + .1183 + .1216 + 2.3953 = 3.0774 \text{ \#/HR}$$

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Computation Sheet For Emission Factors

Calculations Done By HOMER Date 11/27/74

Source PERLITE

$$E_S = \frac{3.0774}{.7077} = 4.348 \text{ \#/TON}$$

$$\boxed{E_{S_{PERT}} = 4.35 \text{ \#/TON PERLITE}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing

In the processing of phosphate rock, four operations are used prior to fertilizer manuf or export. of rock

a) drying
b) grinding
c) material handling
d) calcining

① Ref 040 Table VIII -1 indicates that the production for each of these operations is not the same.

② Ref 047 p146 states "in Florida, where approx 75% of phosphate rock is produced,"

③ Ref 040 p II-1 indicates that Western rock contains organic matter and Carbonate which is removed by Calcination.

We will handle each of the processes separately excepting that we will assume material handling emissions will occur during drying operation or at least all material entering dryer will be handled so as to be considered under the same production quantity as drying.

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Computation Sheet For Industrial Factors

Calculations Done By W. Morrone Date 8-14-74

Source Phosphate Rock Processing (Drying and Handling)

K: Ref 040 Table VIII -1

Drying production and capacity info are given for 1970 and 1980. The calculated $K_{70} = .88$ and $K_{80} = .86$ are obtained by,

$K_{70} = 16.$ [illegible] $= .88$ $\qquad K_{80} = \frac{15.2}{17.6} = .86$

The average of these two value is $K = .87$ which we will use for 1975 and assume to be constant for 1975-1985 period

$$\boxed{K = .87}$$

A:

Referring to the attached graph, compiled from the data in Ref 040 Table VIII -1 we estimate the 1975 production for rock drying as 12.6×10^6 Tons/ of P_2O_5 and the capacity as;

$$\text{Capacity}_{75} = \frac{12.6 \times 10^6}{.87}$$

$$= 14.5 \times 10^6 \ \frac{\text{Tons}}{\text{yr}} \text{ as } P_2O_5$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Drying & Handling)

A: cont'd

Ref 077 Table 4 pg 28 range of P_2O_5 content of Florida pebble rock 31.2 → 35.3 % by wt

Table 5 pg 29 Typical analysis 33% P_2O_5 in rock

we will Us~~ing~~ the mid value in the range of % of Table 4 or the typical value of Table 5 which is 33% P_2O_5 in the rock. This is not exactly typical of all phosphate rock, which will vary throughout the country, however since Ref 047 p146 estimates that 75% of the rock processed comes from Florida we feel this number of 33% as suitably representative.

Converting the production and capacity in terms of P_2O_5 to total rock is performed as follows;

$$\text{Production}_{\substack{\text{rock}\\1975}} = \frac{\text{Prod } P_2O_5}{.33} = \frac{12.6 \times 10^6}{.33} = 38.2 \times 10^6 \ \frac{\text{Tons}}{\text{yr}}$$

$$\text{Capacity}_{\substack{\text{rock}\\1975}} = \frac{\text{Capacity } P_2O_5}{.33} = \frac{14.5 \times 10^6}{.33} = 43.9 \times 10^6 \ \text{Tons/yr}$$

$$\therefore \boxed{A_{\text{Dry \& Hand}} = 43.9 \times 10^6 \ \frac{\text{Ton}}{\text{yr}} \text{ phosphate rock}}$$

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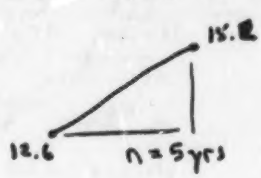
Computation Sheet For Industrial Factors

Calculations Done By D. Marrone Date 8-14-74

Source Phosphate Rock Processing (Drying and Handling)

P_c: The growth of the rock drying processing portion of this industry is estimated from the data on Table VIII -1 of Ref 040 which we have plotted conveniently on an attached graph. The slope of the production curve will be taken as the simple growth rate and applied to 1975 as a base year.

1980 prod = 15.2×10^6 Ton P_2O_5
1975 prod = 12.6×10^6 Ton P_2O_5



$$P_c = \frac{15.2 - 12.6}{5} \div 12.6 = .041$$

$$\therefore P_c = .041 \text{ simple}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Industrial Factors

Calculations Done By William Marrone Date 8-14-74

Source Phosphate Rock Processing (Grinding)

K: Referring to the attached graph which was developed from data in Table VIII-1 Ref 040 we see that the value of K in 1975 ≅ .93 and in 1980 ≅ .96. Comparing these to $K_{70} = .88$ we gather that this portion of the industry is growing to its capacity. Lacking definitive data from other sources on K we will estimate that the average K between 1975 and 1980 will be applicable for the period 1975 to 1980

$$K_{avg} = \frac{.93 + .96}{2} \cong .94$$

$$\therefore \quad \boxed{K = .94}$$

A: The production in terms of P_2O_5 from grinding is obtained from the attached graph;

$$P_{75} = 8 \times 10^6 \ \frac{Ton}{yr} \text{ as } P_2O_5$$

applying the 33% P_2O_5 by wt factor arrived at previously for rock drying we may calculate the 1975 ~~capacity~~ production of rock through grinding

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Grinding)

A: cont'd

$$1975 \frac{\text{Reqd}}{\text{Rock}} = \frac{1975 \text{ Prod } P_2O_5}{.33} = \frac{8\times10^6}{.33} = 24.2\times10^6 \frac{\text{Ton}}{\text{yr}}$$

Now, using the value of K = .94 we obtain the 1975 production capacity

$$A = \frac{24.2\times10^6}{.94} = 25.7\times10^6 \ \frac{\text{Ton}}{\text{yr}} \text{ rock}$$

$$\therefore A = 25.7\times10^6 \frac{\text{Ton}}{\text{yr}} \text{ of rock}$$

Grinding

P_c: The growth in rock grinding is estimated similarly as in the case of rock drying. Referring to the attached graph, the simple growth above 1975 base year is calc as;

$$P_c = \frac{9.7 - 8.0}{5} \div 8.0 = .043$$

$$\therefore P_c = .043 \text{ simple}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Calcining)

K: The data obtained from Ref 040 Table VIII -1 indicates a growth in capacity slightly greater than production for the period 1970 - 1980. We will assume, lacking other information, that the utilization during the period 1975 - 1985 will be best approximated by the ~~avg~~ value of 1980 K = .9

$$\therefore \quad K = .9$$

A: The 1975 Production in terms of P_2O_5 through calcining is $.8 \times 10^6 \frac{Ton}{Yr}$ (from attached graph).

The P_2O_5 content of the calcined rock is approximated from Table 6 pg 30 of Ref 077

P_2O_5 T/D = 520 } after calcination
Total T/D = 1502 }

$$\frac{520}{1502} = .346 \quad \text{or } 34.6\%$$

$$\text{Prod Rock 1975}_{\text{calcining}} = \frac{.8 \times 10^6}{.346} = 2.3 \times 10^6 \frac{TON}{Yr}$$

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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing (Calcining)

A: cont'd

Taking the 1975 Calcinined rock production and the value of $K = .9$ we arrive at the 1975 capacity;

$$A = \frac{2.3 \times 10^6}{.9} = 2.55 \times 10^6 \frac{\text{Ton}}{\text{yr}} \text{ rock}$$

$$\therefore \boxed{A = 2.55 \times 10^6 \frac{\text{Ton}}{\text{yr}} \text{ calcined rock}}$$

P_c: We approximated the growth rate from data on the attached graph. This was based on the base year 1975 and assumed to be simple growth. The production data was used for growth determination

$$P_c = \frac{.993 - .8}{5} \div .8 = .048$$

$$\therefore \boxed{P_c = .048 \text{ simple}}$$

Attachment

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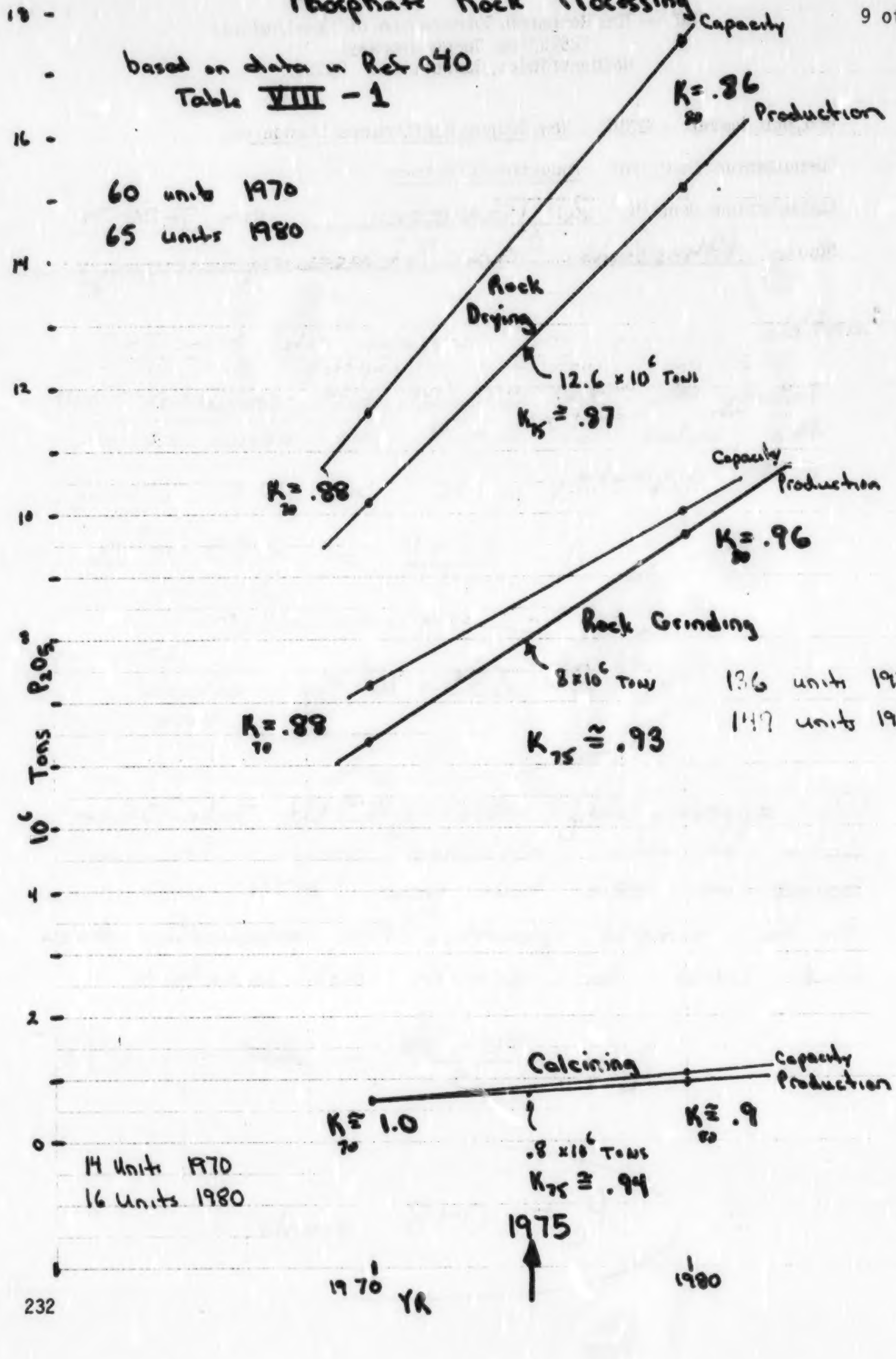
Phosphate Rock Processing



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Computation Sheet For Industrial Factors

Calculations Done By W. Marrone Date 9-26-74

Source Phosphate Rock Processing

P_B: We estimate the obsolecence rate from IRS guideline with the assumption that the rate will be the same for each of the operations in this industry

Ref 037 pg 30 Sec 10.0 (Mining)

Asset guideline life = 10 years

P_B est $\cong 2 \times \mathrm{IRS} = 20$ years

100% Depreciation in 20 years $\Rightarrow \frac{100\%}{20\,\mathrm{yrs}} = 5\%/\mathrm{yr}$ simple

P_B (Drying and Handling) = .05 simple

P_B (Grinding) = .05 simple

P_B (Calcining) = .05 simple

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 8-14-74

Source Phosphate Rock Processing
Particulates

E_u:

The following uncontrolled emission factors were obtained from Reference 047 Table 4.11-1 pg 1-17

	Process	E_u	
use combined value	1. Drying	12 lb/TON rock	14 lb/TON
	2. Material Handling	2 lb/TON rock	
	3. Grinding	2 lb/TON rock	
	4. Calcining	40 lb/TON calcined rock	

Drying and Material handling agree well with data from AP-42 (Ref 075) Table 8.18.1 Dry = 15 lb/Ton rock
M.H. = 2 lb/Ton rock

however, AP-42 reports a value of 20 lb/TON for grinding. The data was referenced to our Ref 047 so we believe the AP-42 to be a possible typo-error. We will use 2 lb/TON until better verification is obtained.

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Computation Sheet For Emission Factors

Calculations Done By W. Morrone Date 8-14-74

Source Phosphate Rock Processing

Particulate cont'd

E_N:

Ref 075 (AP-42) T 8.18-1 lists collection efficiency ranges for control devices on drying, grinding, and material handling.

Drying: 95-99% eff
Grinding: 99.5 - 99.9% eff
Transfer & Storage: 99.5-99.9% eff

For available control in 1975 we will use (assume) the higher value in this range to calculate E_N values

$$E_{\text{Mat Handing}} = .001 \times 2 = .002 \text{ lb/T}$$

$$E_{\text{Drying}} = .01 \times 12 = .12 \text{ lb/T}$$

$$\boxed{\begin{array}{l} E_N = .001 \times E_U \\ E_N = .01 \times E_U \end{array}}$$

$$\boxed{E_N = .122 \text{ lb/TON rock} \quad \left(\text{Drying \& Material Handling}\right)}$$

$$E_{\text{Grinding}} = .001 \times 2 \text{ lb/TON} = .002 \text{ lb/T}$$

$$E_N = .001 \times E_U$$

$$\boxed{E_N = .002 \text{ lb/TON rock} \quad (\text{Grinding})}$$

Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 8-14-74

Source Phosphate Rock Processing

E_N: cont'd

Calcining

Information was obtained on the average control efficiency for particulates from Calcining of Phosphate Rock Ref 047 p231 95% control with wet scrubbers

We found no other data in the literature which would support a higher efficiency level however we assume that a level compreable to control on the rock dryer kiln should be attainable on the calcining kiln.

Until more definitive data appears we will use 99% efficiency

$$E_N = .01 \times E_u = .01 \times 40 \text{ lb/TON}$$
$$= .4 \text{ lb/TON}$$

$$\boxed{E_N = .4 \text{ lb/TON of calcined rock}}$$

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Project Number - 32391 New Source Performance Standards

Computation Sheet For Emission Factors

Calculations Done By William Marrone Date 10-18-74

Source Phosphate Rock Processing

E_S : Particulate

Ref 040 Table VIII -1 gives the number of process units for Drying, Grinding, and Calcining in the years 1970 and 1980.

	1970	1980
Drying & Mat Handling	60	65
Grinding	136	149
Calcining	14	16

We assume that the number of process units in 1975 is midway between these two value such that;

N_{75} Drying = 63 units

N_{75} Grinding = 143 units

N_{75} Calcining = 15 units

Taking the 1975 Production Capacity for each operation and the number of units in 1975 we may estimate a typical process weight rate.

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Computation Sheet For Emission Factors

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Source Phosphate Rock Processing

E_5: Particulate cont'd

	A_{75}	N_{75}	Typical Plant Size
Drying & Mat Hand	43.9×10^6 TON/yr	63	697×10^3 TON/yr
Grinding	25.7×10^6 TON/yr	143	180×10^3 TON/yr
Calcining	2.55×10^6 TON/yr	15	170×10^3 TON/yr

Assuming $16 \frac{hr}{day} \times 350 \frac{d}{yr} = 5600 \frac{hr}{yr}$ we may convert the Typical Plant size on a Ton/yr basis to Ton/yr and eventually lb/hr (Process weight)

Since all material going through each of this processes is not intentionally lost or added to the process weight based on feed is the same as the process weight we calculate on the route of production capacity.

$$\frac{lb}{hr} = \frac{TON}{yr} \times \frac{yr}{5600\ hr} \times 2000 \frac{lb}{TON} \quad \text{(per plant)}$$

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Computation Sheet For Emission Factors

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Source Phosphate Rock Processing

E_s: Particulate cont'd

	Process Weight (Typical Plant)
Drying	249×10^3 lb/hr
Grinding	64×10^3 lb/hr
Calcining	61×10^3 lb/hr

Ref 095 760.2010 H & I identifies the following states as having phosphate rock production;

① Florida
② Georgia
③ North Carolina
④ Tennessee
⑤ Kentucky
⑥ South Carolina
⑦ Arkansas
⑧ Idaho
⑨ Montana
⑩ Utah
⑪ Wyoming

It also states that about 73% of the process rock comes from Florida.

We will develop our estimates of E_s for these processes in the phosphate rock processing industry by weight the Florida Allowable (73%) emissions with the Generalized Average [50 state] process weight rate curve.

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Computation Sheet For Emission Factors

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Source Phosphate Rock Processing

E_s : Particulate cont'd

	Process Wt	Florida Allowable	50 State Allowable
Drying	249×10^3 lb/hr	39.5 lb/hr	50 lb/hr
Grinding	64×10^3 lb/hr	28.0 lb/hr	36 lb/hr
Calcining	61×10^3 lb/hr	27.2 lb/hr	35.5 lb/hr

Weighting, we obtain

Drying $.73\,(39.5) + .27\,(50) = 42.3$ lb/hr

Grinding $.73\,(28.0) + .27\,(36) = 30.2$ lb/hr

Calcining $.73\,(27.2) + .27\,(35.5) = 29.4$ lb/hr

Using 5600 hr/yr we may convert these allowable emission to lb/yr and by dividing by the typical plant output capacity, we obtain E_s in lb/TON product.

$$\frac{\text{lb/hr part} \times 2000\,\text{lb}}{\text{lb/hr rock}} = \frac{\text{lb pt}}{\text{TON Product}}$$

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Computation Sheet For Emission Factors

Calculations Done By W. Marrone Date 10-18-74

Source Phosphate Rock Processing

E_S: Particulate contd

Drying: $E_S = \frac{42.3 \times 2000}{249,000} \cong .34$ lb/TON rock product

Grinding: $E_S = \frac{30.2 \times 2000}{64,000} \cong .94$ lb/TON product

Calcining: $E_S = \frac{29.4 \times 2000}{61,000} \cong .96$ lb/TON product